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THE PRESENT STATUS OF WORK ON THE ECOLOGY OF AQUATIC INSECTS AS SHOWN BY THE WORK ON THE ODONATA[1]

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For a measure of ecological work on aquatic insects in general we will use as a yardstick the present status of our knowledge of the Odonata or dragonflies. This group is more nearly ready for ecological study than are other orders of aquatic insects because it is small in number of species and these are conspicuous so that their description is farthest advanced; also we are personally familiar with the dragonflies and the literature in this field. The size of our problem is further reduced because the small amount of ecological study on Odonata has been limited almost entirely to areas in Europe and North America.

Before proceeding further we wish to point out that one other and more restricted group of aquatic insects has received more study than have the Odonata. This is the family Culicidae, the mosquitoes and their relatives, which as early as 1879 were shown by Sir Patrick Manson to be the carriers of filaria worms. With the discovery in 1898 by Sir Ronald Ross that mosquitoes carried malaria and the further discovery two years later that yellow fever was transmitted by mosquitoes, this group of insects has had more intensive study than has any other group of insects of equal number of species. Because of its direct bearing on human welfare the mosquitoes have had all the forces of medical entomology brought to bear on them. Students of aquatic insects in general would do well to study the methods of research developed by

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men in medical entomology. Several recent publications give methods of culture, of population study and of control. (Peterson, 1934, 1937, and Needham, 1937).

But to return to Odonata: About 3,000 species of dragonflies have been described for the world fauna which count ranks them as a small order of insects. That many beetles have been described in America north of Mexico. Dragonfly species are usually distinct enough from near relatives to be easily described. However, we find a few widely spread forms which can be broken up into subspecific groups. The taxonomic problem at this point becomes difficult as a careful study of subspecific forms has value in direct proportion to the amount of cytological study and of the field study of these forms. Unfortunately for the larger aquatic insects these cannot be crossed and bred in a bottle as can many small flies. Further, in the case of predator insects such as Odonata we lack the extra specific characters which Kinsey, working on Cynips, found in the species of host oak, type of gall and in characters of the alternate generation. Nevertheless, students are already recognizing, but so far not describing, physiological, geographic and hybrid forms of Odonata. We cite two or three such problems:

Didymops transversa (Say) is common on cold spring-fed hill streams about Ithaca, New York, but at Raleigh, North Carolina, this dragonfly thrives on warm muddy ponds. Neither E. B. Williamson nor I could find any morphological differences between specimens from these very diverse environments. Are we dealing here with physiological species? In the Zoological Museum at Ann Arbor is a series of Macromia from the White River, Arkansas. This series of several hundred specimens is a mixture of two described species and an almost equal number of intermediate forms. Are the intermediate specimens hybrids? On the Wabash River in Indiana, no intermediate forms occur; the same two species on the Wabash are always distinct. A careful study of some western dragonflies show a plains form, an intermountain form, a Sonoran form and a Pacific Coast form. This type of distribution is that usually labelled geographic. All of these taxonomic problems are now facing the museum men who in the past have been limited to the study of dead insects. What catalogue name the museum taxonomist will ultimately concede to the student of living insects for such types of living aggregations of interbreeding individuals has

not as yet appeared. Kinsey has called them species. At this point we recommend the reader to Kinsey, "The Origin of Higher Categories in Cynips," 1936, and to Dobzhansky, "Genetics and the Origin of Species," 1937, and Anderson, "The Species Problem in Iris," 1936.

After naming his species the next great problem facing any field entomologist whether a student of land or of water insects is that of the population count. This is not a problem peculiar to aquatic entomology but is one of the more difficult problems facing all economic entomologists. The usual winged insect is an active animal which classes all moving objects larger than itself as possible enemies. Insects tend to avoid the census taker. The entomologist reporting an outbreak cannot assure his chief in Washington that he has not counted the same insect twice or even three times. Until entomologists can develop the technique of a fairly accurate census of insects in the field we will not be able to handle entomological problems statistically. Our mathematics of population will be too dependent on sampling which is something difficult to divorce from the desires of the sampler. Or just as bad, statistical studies may be based too much on laboratory populations. (See Snedecor, 1937.)

As Odonata are predators they occupy the peak of a food pyramid as defined by Elton (1927). Thus in general the individuals of any species in a limited area are not numerous as compared with the individuals of insect species on which they prey. In a small area dragonflies may appear numerous because the same conspicuous individuals fly constantly back and forth on the same beat. The only population study of value is that by Borror (1934) on *Argia moesta* Hagen, a common stream dragonfly of this region. In his study of Argia by a system of marks placed on their wings Borror was able to show the proportions of the two sexes, the sequence of color forms as individuals matured and to give a general idea of the total number in the area studied. C. B. Wilson (1920) attempted estimates on ponds at Fairport, Iowa, by counting the number of exuviae of nymphs at sampling stations.

The number of eggs laid by any species of dragonfly is unknown. Various estimates on partial data have been made. C. B. Wilson's studies on the Bureau of Fisheries' ponds at Fairport, Iowa (1920) are the best. This is data which will probably be difficult to obtain for the larger Anisoptera, but

perhaps can be had with some accuracy for the Zygoptera which can be reared in large cages, if these are placed in the bright sunshine.

Females of such could be caged with males and the eggs deposited actually counted. This, then, could be checked against ovarian egg-counts of virgin females which might prove to be the only count needed. Until we get the basic data of sound population counts and of reproductive ability we will be unable to apply mathematical formulae accurately to ecological problems. On its face it appears to be difficult to count insects that fly as well as do Odonata, but Borror's studies of Argia and all field observations indicate that the majority of the aquatic Odonata (some tropical forms are not aquatic) live as adults in very limited areas. This is especially true where water is in small or discontinuous ponds.

In Odonata and in all aquatic insects one of the basic limiting factors in distribution is the selection of the place of oviposition by the female. The structure of the odonate nervous system and casual observation indicate that the dragonfly is probably eye-minded. On this assumption the place for the eggs is probably selected through the sense of sight. Many female dragonflies will attempt to lay eggs on a wet automobile top or in ponds and reservoirs of crude petroleum. Only a multiplicity of field observations on the habits of particular species will define egg-laying habits. The literature at present contains only casual observations which too often are on egg-laying sites that in some way are unusual. As compared with the much more exact knowledge of oviposition in the codling moth and other pest insects our knowledge of odonate habits is crude in the extreme. Such observations on the selection of habitat by the female which are vital to any study of ecological distribution have not as yet been put on even the simplest statistical basis.

After having been deposited, the eggs of many dragonflies are subject to parasitization by the minute wasps of the family Mymaridae which can fly to them if laid above the water, or can swim to them when deposited in the water. Casual observation indicates that these are especially parasitic on the eggs of dragonflies which inhabit the desert type of pond that contains water only during the spring and early summer. Life history problems of this type could be worked out on the numerous small ponds of our glaciated area.

We have little, if any, knowledge of whether small fish or other aquatic predators eat dragonfly eggs. Eggs of many species of Anisoptera are scattered in the water in June and July when the broods of small fry are just off the nest. Except for some insectivorous birds and a few predaceous insects, insect eggs in general are not often attacked by predators.

The ecological distribution of dragonflies depends first on the flying adult which selects the new territory for hunting and egg deposition. The flying adult is aerial and not aquatic. The finer distribution of the species within the general aquatic habitat may depend more specifically on the behavior of the larva which is truly aquatic. The newly hatched larva may burrow in the mud or the sand of the bottom, may burrow in loose trash on the bottom, may cling to vegetation, or cling to rocks at any one of several levels. In a few species (Archilestes) the larva may even swim rather freely as do the darters and fish that lack an air bladder. We have little data as to whether larval distribution is a response to degree of light, to touch, to temperature, to currents or to varying amounts of gases or other solutes. Probably it is not often a matter of food.

With the great amount of field work on Odonata we are just beginning to get fair data on the seasons of flight. Wesenberg-Lund, of Denmark (1913), gave us our first extensive diagrams of seasons of flight. His form of diagram has been adopted in this country by E. M. Walker, C. F. Byers, the present writer and others. There is considerable casual evidence that species of dragonflies, particularly the one-brooded spring and early summer forms, are ready for emergence but do not emerge until some certain water temperature is reached. Even such simple data have not been collected on the common species, though it could be had by the use of a pocket thermometer.

To do all the things suggested so far, the species of dragonfly must be positively identified, whether in the egg stage, in one of a dozen larval stages or in the adult stage. As already stated the taxonomy of the egg stage and of larval stages is hardly begun. We now know the grown larvae in approximately half of the species north of Mexico, but we have only fair descriptions of the early or first stages of less than 20 of the 365 species for this area. For several years the writer has been collecting from entomological literature the known complete life histories of insects, those which give the length of

each of all the stages, and certain other data. Of American dragonflies we have only two or three such life histories. These species have been painstakingly reared by Professor P. P. Calvert and his student, Miss Lamb. (Calvert, 1929, 1934; Lamb, 1925.) Culture methods are summarized in the recent volume, "Culture Methods for Invertebrate Animals," edited by Professor Needham and sponsored by Section F. of the A. A. A. S. The usefulness of such work will depend on ample and exact illustrations of the various stages.

When we come to the food of dragonflies we have a few good papers based directly on stomach contents; one on Hawaiian species by Warren (1915) and the work of C. B. Wilson on dragonflies on the fish ponds at Fairport, Iowa, in 1920. Field observations have been brought together by Hobby (1933 and 1936).

In the matter of animals that eat Odonata we have a great many odds and ends of records in the literature on fish foods. The first important contributions in this field were made in Forbes' floating laboratory on the Illinois River in the early part of this century. The best bibliography of this literature is that by Gersbacher in the American journal, "Ecology" for July, 1937. Concerning animals which eat flying Odonata we have only the occasional published records of field observations. The present writer has just completed a manuscript which summarizes the data of the U. S. Biological Survey up to 1925 on dragonflies found in the stomachs of birds. Little of this material could be determined to species but it raises innumerable questions such as why certain species of birds take Odonata regularly while others closely related do not. It shows throughout the close relationship between the nature of the food, its abundance, and the size, structure and habits of the bird.

Concerning the actual ecological distribution of dragonflies we have many excellent lists of the dragonflies found in specific types of bogs, marshes, streams, ponds and the larger lakes. These are ecological data of a sort. Probably Professor E. M. Walker's papers on Canadian dragonflies deal more regularly with environmental conditions of the various species than do the writings of other American odonatists. I know of no paper which deals conclusively with the actual limiting factors of distribution as checked by experimental work of any extent.

No paper has appeared which deals with the ebb and flow of a dragonfly population over a period of years. In the

E. B. Williamson library on dragonflies, which is deposited in the Zoological Museum of the University of Michigan, are his detailed notes on the species of Odonata and their relative abundance each season over a period of more than twenty years as found flying on a button-bush woods-swamp (Vanemon Swamp) near Bluffton, Indiana. This is the best set of records we know of but they have never been organized or any part of them published. They show great fluctuations in relative abundance of species and apparently corroborate the writer's (Kennedy, 1922, p. 332) findings at Put-in Bay, Ohio, that gravid, fertilized females must fly long distances (one to five or more miles) and then must oviposit in any water available, where if unfavorable the species may exist one or more years then disappear.

This brief review of our knowledge of one of the most interesting groups of insects shows how little is really known concerning the lives of the less economic species. With the other aquatic insects in North America, the mayflies, caddisflies, stoneflies Hemiptera and Coleoptera less is known as in these groups even the taxonomy is in poor shape and little is known of geographic distribution.

The lack of knowledge of the distribution and habits of aquatic insects in North America can be laid partly to the fact that this area is so rich in undescribed species; the majority of men interested in insects have been tempted or even compelled to help describe new species. American insects are a biological gold mine. A graduate student at Ohio State University in two summers collected 2,000 species on the campus which is a flat city park. Many were new to science. This tremendous job of cataloguing has to go on before physiological and particularly before ecological work can be done with precision. Research on insects is no longer an amateur's job. Knowledge of insects has made amazing strides in two fields, that of medical entomology and that of agricultural entomology. In both fields large research funds have been available. Individual projects of study and control in the hundred thousand dollar level no longer cause comment and two projects, that of the European corn borer and that of the fruit fly in Florida have been operated in the ten million dollar level. In the United States and Canada are employed between 1,000 and 2,000 college trained men in research on insect pests. With the recent realization of the necessity of conservation in

its various forms we can anticipate more funds for studies of aquatic biology. Social pressures will force more funds into these fields of research.

Some of the most advanced ecological research being done at present is that by economic entomologists on various of our farm pests. Out of these lines of research are beginning to emerge general biological principles which help in the control of pests and aid in the prediction of serious outbreaks.

As far as I know the majority of American Odonatists are mostly interested in problems of taxonomy and of geographic distribution. Probably in order to make specific advances in the knowledge of the physiology of aquatic insects we will have to turn to men trained in the techniques of economic entomology. Peterson's recent volumes reviewing insectory methods and apparatus (1934, 1937) show us the great variety of types of research now being carried on by economic entomologists. Such men trained in the study of habits and in the techniques of experimental zoology could show us how to handle the problems of the ecology of aquatic insects. Too much of the work to date on aquatic insects has been done on a few specimens of a species by one man on a single table in the corner of some poorly equipped laboratory. The economic entomologists, if given funds, could operate with the large scale techniques developed in recent years by state and federal entomological staffs.

We append to this review a bibliography of key books and articles especially those with methods and good bibliographies of use in this subject.

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This is the second edition, the first having been published in 1927. There are eighteen brief chapters on subjects usually included in a course in biochemistry, and in addition, chapters on alkaloids and the identification of organic compounds. Many laboratory tests and methods are included. Chapters on vitamins and hormones include many very recent formulae. This book is designed for use in review and is not intended to replace standard texts in biochemistry.—*J. B. Brown.*

Aids to Biochemistry, by E. A. Cooper and S. D. Nicholas, 2nd. Ed. William Wood and Co., Baltimore, 1938. $1.50.

A SPECIMEN OF SOLENOCHILUS PECULIARE FROM THE POTTSVILLE SERIES OF OHIO

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INTRODUCTION

When Miller and Owen described *Solenochilus peculiare* from the Cherokee formation of Missouri in 1934, the holotype was the only specimen known to them. In February, 1936, while a graduate student at the Ohio State University, the writer discovered in the Geological Museum an unidentified specimen from the Lower Mercer limestone at Canton, Ohio, that also appears to be a representative of this species.

SYSTEMATIC DESCRIPTION

1934. *Solenochilus peculiare* Miller and Owen, University of Iowa, Studies in Natural History, Vol. XVI, No. 3, pp. 254–256, Pl. XIX, Figs. 1, 2.
Cherokee formation, Henry County, Missouri.

The Ohio specimen is a fragmentary, somewhat flattened, and almost completely exfoliated internal mold that belonged to a large and presumably subglobose conch. Only the ventral and ventrolateral portion of eight or possibly nine camerae and of the living chamber is preserved. The septate portion appears to possess the innermost layer of the shell and consequently is smoother than the living chamber. The entire preserved portion has a length of 180 mm. measured along the venter, and the conch probably had an original diameter of about 150 mm. The whorl's width at the juncture of the phragmacone and the living chamber is about 90 mm., but distortion and flattening may render this measurement somewhat unreliable.

The whorl is broadly rounded ventrally; its other surfaces are unknown. The internal mold of the phragmacone and also of the living chamber is longitudinally lirate, but only the median ventral lirae are discernible on the latter. The numerous lirae are relatively inconspicuous, closely spaced, and of two different strengths. The difference in strength is most apparent along the median line of the venter where the two median ventral lirae are separated by a wider space than the other lirae, and this space bears two of the less prominent lirae.

The septa are 11 to 12 mm. apart except the four adoral ones which are 8, 6, and 5 mm. apart, respectively, as the living chamber is approached. Even the last camera, upon close examination, is apparently divided into two slightly unequal chambers. The closer spacing of the adoral septa indicates a late mature or gerontic individual.

The sutures are slightly sinuous, and their preserved portions form a shallow, broadly rounded, ventral saddle that is bordered on each side by a similar lobe, and these lobes are in turn bordered by similar ventrolateral saddles. The sutures cannot be traced further dorsad than the ventrolateral saddles.

As in Miller and Owen's holotype the siphuncle is rather small and ventral in position and apparently was in contact with the ventral wall of the conch. The siphuncle is well enough preserved to show its peculiar and interesting structure. In one of the normal camerae the septal neck is 4.5 mm. long and the connecting ring is about 6 mm. long. A short distance apicad of the septum, the septal neck expands in diameter before contracting rather abruptly near its apicad end where it contacts the pyriform connecting ring. In contrast to the septal necks, the connecting rings are more abruptly contracted orad. The connecting rings not only exceed the septal necks in length but also in maximum diameter; and in one camera the connecting ring has an apparent diameter of 6 mm., and the septal neck has an apparent diameter of about 3 mm. In the shortened camerae adjacent to the living chamber the structure of the siphuncle is presumably modified but is not well shown.

REMARKS

This specimen appears to be conspecific with the specimen described by Miller and Owen as *Solenochilus peculiare*. Their holotype has been available for comparison through the courtesy of Mr. Owen. Both specimens are longitudinally lirate on the internal mold in a like manner. As far as can be determined the suture patterns are the same. The relative lengths and diameters of the septal necks and connecting rings and the nature and constriction of the siphuncular segments are comparable. In fact there are no apparent differences by which these two specimens can be separated specifically.

The finding of this species in strata of Pottsville age from widely separated geographic localities is significant, and the discovery of more restricted species in the same strata may lead to more exact stratigraphic correlation.

OCCURRENCE

Mr. H. H. Wolf collected the specimen from the Lower Mercer limestone member of the Pottsville series, Canton, Ohio. It was accessioned to the Ohio State University collection over 40 years ago and was unfortunately overlooked during the preparation of the bulletin on the Pottsville fauna of Ohio.

REPOSITORY

Geological Museum, Ohio State University, Columbus, Ohio, No. 10,128.

Figures 1–3. *Solenochilus peculiare* Miller and Owen. 1, ventral view showing the preserved portion of the phragmacone and living chamber, the nature of the siphuncle is visible in one or two of the camerae; 2, median ventral portion of the phragmacone adjacent to the living chamber photographed to show the nature of the longitudinal lirae; 3, diagrammatic representation of the sutures and siphuncle of the portion of the phragmacone shown in figure 2. All figures approximately × ¾. Canton, Ohio; from the Lower Mercer limestone, Pottsville series.

SIMPLE MODES OF INHERITANCE AND THE STUDY OF TWINS[1]

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Twins, both monozygotic and dizygotic, are of inestimable value in the study of the interaction of heredity and environment in the development of human traits. With the exception of mutations which may occur during the life of the individual, intra-pair variations in monozygotic twins are due to factors other than heredity. Many implications easily follow in the interpretation of experimental data based on the study of twins, not all of which are necessarily true. One such implication is that when intra-pair variation in some trait is greater in dizygotic than in monozygotic twins, such differences are a measure of the extent to which heredity is responsible for the trait. While it is true that the differences between the two types of twins are due largely to heredity, yet it must be remembered that dizygotic twins are as similar in hereditary make-up as brothers and sisters, and thus such comparisons give us only a partial estimate as to the role played by hereditary factors. Comparisons of monozygotic twins with foster sibs or unrelated pairs of individuals reared in orphanages should give a more accurate basis for evaluating the role of heredity. Dizygotic twins and sibs, however, should also be included in such studies. Members of twin pairs are contemporaries, and thus have more similar environments than sib or random pairs with age discrepancies. Moreover, the prenatal environment of twins, due to crowding and possible imbalances of fetal blood supply, is different from that of single born individuals. While such conditions would not affect many genetic traits, such as blood types and skin pigmentation, yet it has been demonstrated that left-handedness and associated traits occur with greater frequencies in both types of twins than in single born individuals. Recent studies of dermatoglyphics (Cummins, Leche, and McClure, 1932; Leche, 1933) have brought

[1]Genetic Studies of Monozygotic Twins, No. VI.

out evidence that handedness has a genetic basis. As dizygotic twins and sibs have, on the average, the same degree of genetic similarity, comparisons of dizygotic twins with sibs should give us a measure of the part the unusual prenatal environment of twins plays in bringing about intra-pair differences. Differences between monozygotic twins reared together, minus the differences between dizygotic twins and sibs, should give us a much more accurate estimate of the part played by heredity, than comparisons only of the two types of twins.

The erroneous statement is sometimes made (Rosanoff et al., 1937) that although studies of twins are of great value in estimating the relative parts played by heredity and environment in the etiology of various traits, such data tell us absolutely nothing in regard to the *mode* of inheritance. It has recently been shown (Cotterman, 1937) that intra-pair sib comparisons can be used in the determination of whether or not a given trait could be due to single factor inheritance, although not necessarily indicating which phenotype is dominant. Similar methods can be employed in the analysis of data obtained from dizygotic twins, and may also be made to include a single pair of factors with incomplete dominance, sex-linked and sex-influenced factors.

A SINGLE PAIR OF FACTORS, WITH AND WITHOUT DOMINANCE

For a single pair of allelomorphs with incomplete dominance, A and a, let us allow p to represent the frequency of gene A, and q the frequency of gene a. Then, in a population which has reached quilibrium,

$$p + q = 1$$

Also

$$p^2 + 2pq + q^2 = 1$$

p^2 = frequency of genotype AA
$2pq$ = frequency of genotype Aa
q^2 = frequency of genotype aa

Let us designate individuals of dominant phenotype by D, those of blending phenotype by I, and those of recessive phenotype by R. Table I shows all the possible types of matings, their frequencies, and also the relative frequencies of the six possible dizygotic twin or sib pair combinations.

Totaling, we find the frequencies of the various types of pairs to be as follows:

$$\begin{aligned}
DD &= p^4 + p^3q + \tfrac{1}{4}p^2q^2 &&= \tfrac{1}{4}p^2(1 + p)^{2*} \\
II &= p^3q + 3p^2q^2 + pq^3 &&= p(1 - p)\,(1 + p - p^2) \\
RR &= \tfrac{1}{4}p^2q^2 + pq^3 + q^4 &&= \tfrac{1}{4}(1 - p)^2\,(2 - p)^2 \\
DI &= 2p^3q + p^2q^2 &&= p^2(1 - p^2) \\
RI &= 2pq^3 + p^2q^2 &&= p(1 - p)^2\,(2 - p) \\
DR &= \tfrac{1}{2}p^2q^2 &&= \tfrac{1}{2}p^2(1 - p)^2
\end{aligned}$$

In an allelomorphic pair where dominance is complete, individuals would necessarily be D or R, and pairs DD, DR and

TABLE I

	Matings	Offspring					
		DD	II	RR	DI	RI	DR
p^4	♂AA × ♀AA	p^4	0	0	0	0	0
$2p^3q$	AA × Aa	$\frac{1}{2}p^3q$	$\frac{1}{2}p^3q$	0	p^3q	0	0
p^2q^2	AA × aa	0	p^2q^2	0	0	0	0
$2p^3q$	Aa × AA	$\frac{1}{2}p^3q$	$\frac{1}{2}p^3q$	0	p^3q	0	0
$4p^2q^2$	Aa × Aa	$\frac{1}{4}p^2q^2$	p^2q^2	$\frac{1}{4}p^2q^2$	p^2q^2	p^2q^2	$\frac{1}{2}p^2q^2$
$2pq^3$	Aa × aa	0	$\frac{1}{2}pq^3$	$\frac{1}{2}pq^3$	0	pq^3	0
p^2q^2	aa × AA	0	p^2q^2	0	0	0	0
$2pq^3$	aa × Aa	0	$\frac{1}{2}pq^3$	$\frac{1}{2}pq^3$	0	pq^3	0
q^4	aa × aa	0	0	q^4	0	0	0

RR. The frequency of DD pairs would be the sum of the frequencies of DD, II, and DI pairs with incomplete dominance which equals $\frac{1}{4}p(4 + 5p - 6p^2 + p^3)$. Similarly, the frequency of DR pairs would equal the sum of DR and RI pairs with incomplete dominance, which is $\frac{1}{2}(1 - p)^2\,(4 - p)$. The frequency of RR pairs would be the same for complete as for incomplete dominance, $\frac{1}{4}(1 - p)^2(2 - p)^2$.

*The writer is indebted to Mr. C. W. Cotterman for aid in the simplification of formulae.

TABLE IIA

Gene Frequencies P	Q	Single Pair Factors with Blending DD	II	RR	DR	DI	RI
.01	.99	.0000255025	.00999801	.9703235025	.000049005	.00009999	.01950399
.05	.95	.00068906	.04975625	.857937065	.001128125	.00249375	.08799375
.10	.90	.003025	.0981	.731025	.00405	.0099	.1539
.15	.85	.0074328125	.14370625	.6182453125	.008128125	.02199375	.20049375
.20	.80	.0144	.1856	.5184	.0128	.0384	.2304
.25	.75	.0244140625	.22265625	.4306640625	.017578125	.05859375	.24609375
.30	.70	.038025	.2541	.354025	.02205	.0819	.2499
.35	.65	.0558140625	.27925625	.2875640625	.0258781255	.10749375	.24399375
.40	.60	.0784	.2976	.2304	.0288	.1344	.2304
.45	.55	.1064390625	.30875625	.1816890625	.030628125	.16149375	.21099375
.50	.50	.140625	.3125	.140625	.03125	.1875	.1875
.55	.45	.1816890625	.30875625	.1064390625	.030628125	.21099375	.16149375
.60	.40	.2304	.2976	.0784	.0288	.2304	.1344
.65	.35	.2875640625	.27925625	.0558140625	.0258781255	.24399375	.10749375
.70	.30	.354025	.2541	.038025	.02205	.2499	.0819
.75	.25	.4306640625	.22265625	.0244140625	.017578125	.24609375	.05859375
.80	.20	.5184	.1856	.0144	.0128	.2304	.0384
.85	.15	.6182453125	.14370625	.0074328125	.008128125	.20049375	.02199375
.90	.10	.731025	.0981	.003025	.00405	.1539	.0099
.95	.05	.857937065	.04975625	.00068906	.001128125	.08799375	.00249375
.99	.01	.9703235025	.00999801	.0000255025	.000049005	.01950399	.00009999

TABLE IIB

Gene Frequencies		Complete Dominance		
p	q	DD	DR	RR
.01	.99	.0101235025	.019552995	.9703235025
.05	.95	.05293906	.089121875	.857937065
.10	.90	.111025	.15795	.731025
.15	.85	.1731328125	.208621875	.6182453125
.20	.80	.2384	.2432	.5184
.25	.75	.3056640625	.263671875	.4306640625
.30	.70	.374025	.27195	.354025
.35	.65	.4425640625	.269871875	.2875640625
.40	.60	.5104	.2592	.2304
.45	.55	.5766890625	.241621875	.1816890625
.50	.50	.640625	.21875	.140625
.55	.45	.7014390625	.192121875	.1064390625
.60	.40	.7584	.1632	.0784
.65	.35	.8108140625	.133371875	.0558140625
.70	.30	.858025	.10395	.038025
.75	.25	.8994140625	.076171875	.0244140625
.80	.20	.9344	.0512	.0144
.85	.15	.9624453125	.030121875	.0074328125
.90	.10	.983025	.01395	.003025
.95	.05	.995687065	.003621875	.00068906
.99	.01	.9998255025	.000148995	.0000255025

Table II shows the expected ratios of the various types of pairs, for different values of p and q, for both complete and incomplete dominance. It can readily be seen that the amount of information concerning the inheritance of a trait conveyed by obtaining the ratios of the various types of pairs depends upon the number of pairs studied, and also, to some degree, upon the frequencies of the genes involved. If the frequency of the recessive gene (where dominance is complete) were .80, the ratio obtained from the various types of pairs is approximately the same as when q has a frequency of .60, but in this

instance the total numbers of the two phenotypes in the population studied would enable us to determine which gene was dominant. At a frequency of approximately .70 for q, DD and RR pairs occur with equal frequency, and DR pairs at their maximum frequency, .27+. We would not, of course, determine which phenotype was dominant. If, in a group of dizygotic twins or sib pairs, the percentage of DR pairs significantly exceeds 27%, variation in the trait cannot be due solely to inheritance, based on a single pair of autosomal genes with complete dominance.

TABLE III

Frequencies	Matings	♂ ♂			♀ ♀			♂ ♀		
		DD	DR	RR	DD	DR	RR	DD	DR	RR
p^3	♂ A × ♀ AA	p^3	0	0	p^3	0	0	p^3	0	0
$2p^2q$	A × Aa	$\frac{1}{2}p^2q$	p^2q	$\frac{1}{2}p^2q$	$2p^2q$	0	0	p^2q	p^2q	0
pq^2	A × aa	0	0	pq^2	pq^2	0	0	0	pq^2	0
p^2q	a × AA	p^2q	0	0	p^2q	0	0	p^2q	0	0
$2pq^2$	a × Aa	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$
q^3	a × aa	0	0	q^3	0	0	q^3	0	0	q^3

In a trait where dominance is incomplete, the situation is more complex, because there are six instead of three types of pairs. Consequently, a much larger number of pairs would be necessary to obtain an accurate ratio. There is some compensation for this difficulty, in that where six instead of three types of pairs are included in the ratio, the precision of our ratios is likewise greater. If not enough pairs can be collected for significant ratios of all six types, pairs may be classed as concordant or discordant, the former group being the sum of DD, II and RR pairs, and the latter group the sum of DI, RI and DR pairs. Where dominance is complete, concordant pairs would of course include DD and RR pairs, and discordant would still include only DR.

There has been considerable data brought together by various investigators, giving ratios of concordant to discordant

dizygotic twin pairs, in respect to a number of traits. Unfortunately, almost without exception, only one type of concordant pair is considered, and moreover, the twins have been selected for the trait in question. Thus we have no way of knowing, from such data alone, the frequencies of the various phenotypes in the population as a whole.

SEX-LINKED FACTORS

When dealing with sex-linked factors, we have nine types of pairs, depending on sex as well as trait phenotype. Table III shows the various types of matings, and the ratios of the various types of pairs.

Totaling, we find the frequency of each type of combination to be as follows:

DD ♂	$= p^3 + \frac{3}{2} p^2q + \frac{1}{2}pq^2$	$= \frac{1}{2}p(1 + p)$
DR ♂	$= p^2q + pq^2$	$= p(1 - p)$
RR ♂	$= q^3 + \frac{3}{2} pq^2 + \frac{1}{2}p^2q$	$= \frac{1}{2}(1 - p)\ (2 - p)$
DD ♀	$= p^3 + 3\ p^2q + \frac{3}{2}\ pq^2$	$= \frac{1}{2}p\ (3 - p^2)$
DR ♀	$= pq^2$	$= p(1 - p)^2$
RR ♀	$= q^3 + \frac{1}{2}pq^2$	$= \frac{1}{2}(1 - p)^2\ (2 - p)$
DD ♂ ♀	$= p^3 + 2p^2q + \frac{1}{2}\ pq^2$	$= \frac{1}{2}p(1 + 2p - p^2)$
DR ♂ ♀	$= p^2q + 2pq^2$	$= p(1 - p)\ (2 - p)$
RR ♂ ♀	$= \frac{1}{2}pq^2 + q^3$	$= \frac{1}{2}(1 - p)^2(2 - p)$

Table IV shows the various ratios for the three types of pairs for various gene frequencies. It will be noted that the varying percentages of discordant male pairs form a symmetrical distribution, the highest value being .25 where both genes have a frequency of .50. This frequency is, of course, the same as that for random male pairs in the general population. While the fact that nine types of pairs existing in sex-linked factors introduces greater complications, there is some compensation in that differences in the occurrence in the two sexes would rather easily become apparent, and the only other type of inheritance likely to show such sexual discrepancies would be that involving sex-influenced factors.

SEX-INFLUENCED FACTORS

In a single factor trait which shows reversal of dominance in the two sexes, we can readily obtain the expected ratios at various gene frequencies for both male and female pairs by reference to Table II. Suppose, for example, male pairs fit

TABLE IV

		♂ ♀			Sex-Linked Factors ♂ ♂			♀ ♀		
P.	Q.	DD	DR	RR	DD	DR	RR	DD	DR	RR
.01	.99	.0050995	.019701	.9751995	.00505	.0099	.98505	.0149995	.009801	.9751995
.05	.95	.0274375	.092625	.8799375	.02625	.0475	.92625	.07493755	.045125	.8799375
.10	.90	.0595	.171	.7695	.055	.09	.855	.1495	.081	.7695
.15	.85	.0958125	.235875	.6683125	.08625	.1275	.78625	.2233125	.108375	.6683125
.20	.80	.136	.288	.576	.12	.16	.72	.296	.128	.576
.25	.75	.1796875	.328125	.4921875	.15625	.1875	.65625	.3671875	.140625	.4921875
.30	.70	.2265	.357	.4165	.195	.21	.595	.4365	.1470	.4165
.35	.65	.2760625	.375375	.3485625	.23625	.2275	.53625	.5035625	.147875	.3485625
.40	.60	.328	.384	.288	.28	.24	.48	.568	.144	.288
.45	.55	.3819375	.383625	.2344375	.32625	.2475	.42625	.6294375	.136125	.2344375
.50	.50	.4375	.375	.1875	.375	.25	.375	.6875	.1250	.1875
.55	.45	.4943125	.358875	.1468125	.42625	.2475	.32625	.741825	.111375	.1468125
.60	.40	.552	.336	.112	.48	.24	.28	.792	.096	.112
.65	.35	.6101875	.307125	.0826875	.53625	.2275	.23625	.8376875	.079625	.0826875
.70	.30	.6685	.273	.585	.595	.21	.195	.8785	.063	.0585
.75	.25	.7265625	.234375	.0390625	.65625	.1875	.15625	.9140625	.046875	.0390625
.80	.20	.784	.192	.024	.72	.16	.12	.944	.032	.024
.85	.15	.8404375	.146625	.0129375	.78625	.1275	.08625	.9679375	.019125	.0129375
.90	.10	.8955	.099	.0055	.855	.09	.055	.9855	.009	.0055
.95	.05	.9488125	.049875	.0013125	.92625	.0475	.02625	.9963125	.0023750	.0013125
.99	.01	.9899505	.009999	.0000505	.98505	.0099	.00505	.9998505	.000099	.0000496

single factor inheritance with complete dominance, with p at a frequency of .10, and q at a frequency of .90. If sex-influenced, female pairs should fit the same mode of inheritance, but at a value of .90 for p. and .10 for q.

TABLE V

		Sex-Influenced Factors, ♂ ♀ Pairs		
P	Q	DD	DR	RR
.01	.99	.0194794975	.019849005	.9609714975
.05	.95	.1499296875	.033634375	.8164359375
.10	.90	.151975	.10305	.744975
.15	.85	.1969359375	.263128125	.5399359375
.20	.80	.2256	.3328	.4416
.25	.75	.2412109375	.392578125	.3662109375
.30	.70	.246975	.44205	.310975
.35	.65	.2460609375	.480878125	.2730609375
.40	.60	.2416	.5088	.2496
.45	.55	.2366859375	.525628125	.2376859375
.50	.50	.234375	.53125	.234375
.55	.45	.2376859375	.525628125	.2366859375
.60	.40	.2496	.5088	.2416
.65	.35	.2730609375	.480878125	.2460609375
.70	.30	.310975	.44205	.246975
.75	.25	.3662109375	.392578125	.2412109375
.80	.20	.4416	.3328	.2256
.85	.15	.5399359375	.263128125	.1969359375
.90	.10	.744975	.10305	.151975
.95	.05	.8164359375	.033634375	.1499296875
.99	.01	.9606714975	.019849005	.0194794975

In unlike-sexed pairs, we find upon examination of Table I, the following ratios:

$$DD = 2p^3q + \tfrac{3}{4}\, p^2q^2 + p^4 = \tfrac{1}{4}p^2(3 - p\,(1 + p)$$
$$DR = 2p^3q + 2pq^3 + 4.5p^2q^2 = p(1 - p)\,(4 + p - p^2)$$
$$RR = 2pq^3 + \tfrac{3}{4}\, p^2q^2 + q^4 = \tfrac{1}{4}(1 - p)^2(4 - p^2)$$

Table V gives the ratios at various gene frequencies.

It can readily be seen that where a trait is dependent solely on heredity, based on a single pair of allelomorphs, the ratio of concordant pairs and discordant pairs may be of value in suggesting the mode of inheritance. Just how precise the information may be depends upon the number of pairs investigated, and the gene frequencies. If no discordant pairs are found in identical twins, and if fraternal twins show significantly more than 27% of discordant pairs, where only two phenotypes are known and where the sex of the pairs does not affect the ratios, we can be sure that more than a single pair of genes is involved in the expression of the trait in question.

TABLE VI

Matings	Frequency	Proportion of Discordant Pairs in Progeny	Proportion of Total
♂ AO × ♀ AA	.0245	0	0
AO × AO	.1225	.375	.0459375
AO × OO	.1575	.5	.07675
AO × BB	.00175	.5	.00875
AO × BO	.03325	.75	.0264375
AO × AB	.01050	.5	.00525
AA × AA	.0049	0	0
AA × AO	.0245	0	0
AA × OO	.0315	0	0
AA × BB	.00035	0	0
AA × BO	.00665	.5	.003375
AA × AB	.00210	.5	.00105
OO × AA	.0315	0	0
OO × AO	.1575	.5	.07875
OO × OO	.2025	0	0
OO × BB	.00225	0	0
OO × BO	.04275	.5	.021375
OO × AB	.0135	.5	.00675
BB × AA	.00035	0	0
BB × AO	.00175	.5	.00875
BB × OO	.00225	0	0

TABLE VI—[*Continued*]

Matings	Frequency	Proportion of Discordant Pairs in Progeny	Proportion of Total
♂ ♀ BB × BB	.000025	0	0
BB × BO	.000475	.5	.0002375
BB × AB	.00015	.5	.000075
BO × AA	.00665	.5	.003375
BO × AO	.03325	.75	.0264375
BO × OO	.04275	.5	.0213750
BO × BB	.000475	0	0
BO × BO	.009025	.375	.00336975
BO × AB	.00285	.5	.001425
AB × AA	.00210	.5	.00105
AB × AO	.01050	.5	.00525
AB × OO	.0135	.5	.00675
AB × BB	.00015	.5	.000075
AB × BO	.00285	.5	.001475
AB × AB	.0009	.375	.0003375
		Total discordant	.35440725

MULTIPLE ALLELOMORPHS

While it is possible to set up tables for ratios of various types of pairs at given gene frequencies for series of three or more allelomorphs, similar to those given for single pairs of allelomorphs, the complications are tremendously increased and their practical applications in determining modes of inheritance would not seem to be sufficient to justify their construction. If the frequencies of the various genes and their interactions are known, however, such knowledge may be of value in twin diagnosis. Let us consider how the blood groups may be of value in this connection.

Genes A and B show incomplete dominance in respect to each other, but both are dominant to gene O. The frequencies of these genes vary, of course, depending upon race. In North American Whites (Snyder, 1927) the relative percentages of the blood groups are approximately: A—42, O—45, B—10,

and AB—3. Allowing p to equal the frequency of gene A, q the frequency of gene B, and r that of O, we obtain the following genotypic ratio: AA—.07; AO—.35; BB—.005; BO—.095; OO—.45; and AB—.03. Let us now determine what percentage of fraternal twin and sib pairs would be expected to be discordant in blood group. As shown in Table VI, this can be accomplished by tabulating the frequency of all types of matings, and determining what percentage of paired offspring would be discordant. As shown in Table VI we should find such variation in approximately 35% of fraternal twins, in North American Whites.

Various research workers (Diehl and von Verschuer, 1933; Levit, 1935; Rife, 1934–37) have used blood grouping as confirmatory evidence of monozygosity, and in a total of several hundred pairs, assumedly monozygotic twins have never shown intra-pair variation in blood groups. There is the possibility, however, that selection for monozygosity may have been too rigid, and thus some less similar pairs of monozygotic twins classed as dizygotic. In a large group of twins, separated into classes according to zygosity, we should expect, if selection for monozygosity has not been too rigid, approximately 65% of the dizygotic twins to be of the same blood group. If the percentage of concordance exceeds this figure significantly, we may be justified in assuming that selection for identity has been too rigid, and that some of the assumedly dizygotic twins are monozygotic.

The M and N blood reactions may also be of use in this connection. In North American Whites (Wiener, 1934; Hyman, 1935) the relative proportions of the three types are MN—50, M—28, and N—22. M and N are a pair of allelomorphs lacking dominance. The frequency of gene M is therefore .53 and that of N, .47. Referring to Table IIa, we find that the ratio of discordant types (sum of ratios in columns 4, 5 and 6) in blending inheritance, with gene frequencies of from .45–.55 to .50–.50 is approximately 40%. As the M and N genes and the blood group genes have been shown not to be linked (Wiener, 1932), the proportion of sib and dizygotic twin pairs showing concordance in both traits should approximate $.65 \times .60 = .39$. In a similar manner, more independent traits whose mode of inheritance and gene frequencies are known could be added to the formula, thereby increasing its efficiency.

CONCLUSIONS

Comparisons of identical with fraternal twins are of primary importance in obtaining partial evaluations of the relative roles played by heredity and environment in bringing about variation in human traits. Where simple types of inheritance are involved, data obtained from fraternal twins may be of value in suggesting the exact mode of inheritance. Such data, while not affording the most efficient method for determining manners of inheritance, are valuable by-products of twin studies primarily designed with other objectives in mind. In twin diagnosis, data taken from assumedly dizygotic twins concerning the occurrence of traits, whose manners of inheritance are known, may be of value in determining whether or not selection for monozygosity has been too rigid.

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Some Good Pointers for the Taxonomist

The discussions of problems in systematic work as presented in "Procedure in Taxonomy" are of value to all workers, especially the younger workers in this field. Many of the more important sources of difficulty in work of this type are briefly discussed; such as for instance taxonomic units employed by various authors and the excessive number of categories of this type; the use, selection, preservation and kinds of type specimen; the description of the type; specific names and their choice; the many questions of synonymy; the use of Latin terms and their abbreviations and a rather complete appendix dealing with the more important international rules of Zoölogical Nomenclature and the summaries of the opinions rendered by the international committee. The discussion is concisely and ably presented.

—*Dwight M. DeLong.*

Procedure in Taxonomy, by Edward T. Schenk and John H. McMasters. vii+72 pp. Stanford University Press, Stanford University, California, 1937. $2.00.

THE LARVAL AND PUPAL STAGES OF TWO TROPICAL AMERICAN BUTTERFLIES

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Athena petreus (Cramer) has become established in southern Florida and is now a frequently encountered insect in the "hammocks" around Miami. So far as I know no description of the early stages of any species of *Athena* has been published and it was with some excitement that I watched oviposition by a female of *petreus* on a small fig tree. The fig species, determined by Dr. Phillips of the University of Miami, was *Ficus brevifolia*. Two eggs were obtained but the attempt to rear the larvae was unsuccessful. Five days later, on May 30, a full grown larva was found, again on *F. brevifolia*. This larva,

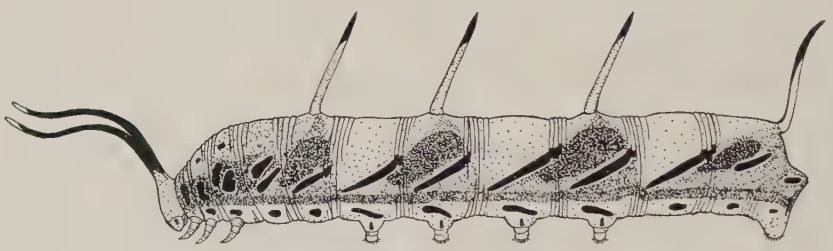

Fig. 1. Larva of *A. petreus*.

when brought into the laboratory, immediately prepared for pupation and the chrysalis was revealed on June 1. The period of pupation was surprisingly short; a male butterfly emerged on June 5. The drawings accompanying this article were made from notes and from photographs which were not clear in some details such as segmentation. The figures, while diagrammatic to some extent, will enable recognition of the stages should they be encountered.

Larva.—General color brick red; head lighter in color and bearing a pair of flexible, white-tipped filaments. The dorsal surface of the body bears four high spines; these red with black tips. The caudal spine is edged with white. Three pink, saddle-like areas lie between the spines. On each side of every segment is a shining black, elongate

mark; these edged with white except on the first three segments. There are also irregular, opaque black marks lateral to and below the spines. Length of larva, 37 mm.

Chrysalis.—Light green in color with the dorsum near middle armed with a high forked spine (black). A series of black spines of various heights succeeds this posteriorly with several very short spines scattered on the sides. The dorsum of the thorax bears a shining black boss. On the humeral angle there is a long, black and green spine curved forward and downward. Length of pupa, 17 mm.

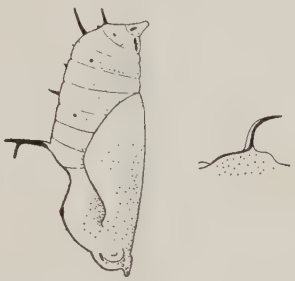

Fig. 2. (Left) Chrysalis of *A. petreus.*
Fig. 3. (Right) Humeral spine of chrysalis.

A number of hesperiid larvae were found on small specimens of red mangrove, *Rhizophora mangle,* which were in heavy shade cast by higher growth. Only one of these was reared and yielded a specimen of *Phocides batabano* (Lucas). All the remaining larvae, eighteen in number, were parasitized and eventually died. The early instars of the larva of *batabano* are purplish-brown with a saffron yellow ring encircling each segment and a similarly colored spot on the head at the base of each mandible. In the last instar the larva becomes covered with a powdery, white exudate which masks the markings. Its features are typically hesperiid though the body is stouter than in most N. A. species of this family. The pupa is without conspicuous markings or structures which would permit identification. No doubt close comparisons with other hesperiid pupae would reveal differential characters.

THE IMPORTANCE OF PHYLOGENETIC TAXONOMY IN SYSTEMATIC BOTANY[1]

JOHN H. SCHAFFNER

The main interest of the older taxonomists was the discovery and description of species, which to them were units or entities self-contained and complete as they had come from the hand of the Creator. Linnaeus was so far possessed with this species idea that he wrote the well-known phrase: "The tyro makes systems, the expert makes species." However expert Linnaeus may have been in making species, he certainly was the most extreme tyro when he attempted to bring some systematic order into the chaos of the known species of his time. He made 23 classes of Phanerogamia and one class of Cryptogamia, bunching together into this class all the known Algae, Fungi, Liverworts, Mosses, Ferns, Horsetails and Lycopods.

When Darwin wrote his first great work on evolution, it was still the origin of species, the more or less discrete units of plants and animals, that was the main object of interest. But the proper study of the species should be made in its relation to all the species in the genus. When this is done the isolated species unit becomes of subordinate interest and importance both in evolution and taxonomy.

Just as when one is studying Shakespeare's Hamlet, for example, one can study the isolated words and recognize them by their letters, as one recognizes a species by its specific characters. Such a study is interesting but one does not get much insight into the real Hamlet nor into the soul of Shakespeare in this way. But after the letters, words, and sentences have all been arranged in their proper paragraphs, scenes, and acts something altogether marvelous appears to grip the intellect and the imagination. The taxonomist has in the systematic study of the plant kingdom a problem comparable to a study of Shakespeare's Hamlet in all of its literary, artistic and scientific aspects. He deals with the individual plant and its characteristics, measuring, numbering, weighing and judging of qualities; for he knows that the ancient author of the apocryphal "Wisdom of Solomon" was correct when he wrote

[1]Papers from the Department of Botany, The Ohio State University, No. 357.

that all things are ordered in measure and number and weight. But the real taxonomic problem begins when the measuring and numbering and weighing are done. If interest in taxonomy is to be continued, the student must be shown that there is something beyond the mere measuring and weighing and numbering.

The most complex problem which can be presented to the reasoning human mind is this organic system of plants and animals which surrounds us on all sides. The taxonomist is from the very beginning confronted by a bewildering array of characters, potentialities, and reactions of different magnitudes and the first fundamental problem is to make an inventory of these characteristics by placing them into their proper categories. After taking a general survey of the situation, three general classes of characteristics or potentialities can be distinguished. First are the general fundamental potentialities which form an accumulation series from the level of the lowest bacteria to the level of the angiosperms, together with additional accumulative potentialities appearing in the distinct phyletic lines. Second are the great segregative potentialities, which establish the group limits of smaller and smaller extent from the distinctive phylum characters through the series of class, order, family and genus characters or of still smaller segregative groups. Third are the nearly endless numbers of small specific and varietal characters and their potentialities which are the genes or groups of genes and the changing of which through ordinary mutations does not affect the more fundamental group characteristics or even disturb to any extent the taxonomic position of the species. But the potentialities whether general or specific in nature, can only be inferred from a study of the characters developed through the physiological activity of the cells and tissues during growth and during the general ontogenetic cycle. It soon becomes evident that a given hereditary system will often not produce the same characters in one ecological environment as in another. Thus a plant of a given variety of hemp may come to maturity when 8 inches high, or it may not attain maturity until it is 8 feet or more in height. It may begin to bloom in 2 weeks after the seedling breaks through the ground or not until it has attained an age of 8 months. It may be pure in sex expression, either staminate or carpellate, or it may be a bisporangiate individual producing both stamens and carpels. In addition to the uncertainty

produced by fluctuation the systematist is still further troubled in the study of some groups by the easy hybridization of both near and distant types, so that what he may consider as a distinct species may fall to pieces in its very first reproductive phase.

The first problem then in making a study of phyletic groups, whether great or small, is to make an inventory of the general fundamental potentialities and reactions responsible for the accumulated characteristics evolved in the plant kingdom. The fundamental potentialities are those which have been accumulated in the general plant series and are apparently never lost and very rarely inhibited by inhibitative potentialities. In a few cases they may progress to a more advanced condition, however, through the greater perfection of the given reaction system. One can without a very minute study of characters and processes easily discover at least 100 such accumulated, general, fundamental potentialities, appearing in the seven successively higher divisions or subkingdoms of the living plants as follows:

1. Protophyta—18 accumulative fundamental potentialities.
2. Nematophyta—18 + 12 = 30.
3. Bryophyta—30 + 15 = 45.
4. Pteridophyta Homosporae—45 + 15 = 60.
5. Pteridophyta Heterosporae—60 + 10 = 70.
6. Gymnospermae—70 + 15 = 85.
7. Angiospermae—85 + 15 = 100.

After such a general study, the problem must be restricted to the special subdivisions, to the segregative characters of the main phyletic groups; but each higher division is to be considered in relation to all the divisions in the general group until one has disposed of this group system as far as the genus. At this point the most important problem is reached. For the genus contributes part of the name of a plant and this is of fundamental concern to society in general, often much greater than to the systematic botanist himself. Because of this universal and practical aspect, the specialist should consider the effect of his work on society in general and not merely determine whether his segregations and lumpings seem reasonable to himself. In this respect phylogenetic thinking can aid decidedly in the establishment of rational genera. The question will then arise as to the harmoneous treatment of the particular

group in relation to the whole, and in relation to the segregations in other similar families. How shall any one decide what is a good and reasonable genus? Shall there be but a single distinctive character or shall there be a greater or smaller aggregate of characters considered in the establishment of a genus and what shall be the magnitude or importance of the characters? Is there not some way that we might come to a fairly scientific conception of the genus group, or must we be ever at the mercy of the genus "splitters" until every linneon becomes a "genus"? For example, it does not seem sensible to put the red maple and the silver maple into two genera. One shudders to think of the consequences if all genera were divided up to the same extent as Acer has been recently. But whatever the degree of splitting or lumping, it seems reasonable to segregate both genera and species on fewer and smaller characters in the lower plants than in the higher.

The phylogenetic viewpoint is also of very great importance in the segregation of species and in determining their relative positions in the genus. In a study of Equisetum, it becomes evident that the internodal ridge with a double row of tubercles or with a bicarinate condition has been attained independently in at least four distinct phyletic lines. So in a comparative study of *E. praealtum* Raf. and *E. hiemale* L. it becomes obvious that the simple internodal ridge of *E. praealtum* with a single line of tubercles is the more primitive condition. The internodal ridge of *E. hiemale* with a double row of tubercles indicates the addition of an important new progressive potentiality, and the plant is thus a distinct step in advance of *E. praealtum*. Both are good species but if one is to be regarded as a variety of the other the phylogenetic point of view will require that *E. hiemale* be considered a variety of *E. praealtum*.

The phylogenetic treatment of the species of a genus is a great aid in the study of geographic distribution. In the case of Equisetum there is quite a remarkable correspondence between the present geographic distribution of the species and the ascertained phylogenetic relation.

Because of a lack of knowledge of the general evolutionary sequence and because the whole grass series was topsy-turvy, with *Zea Mays* L. at the bottom instead of at the top where it belongs, there have been all sorts of odd hypotheses in relation to the nature and origin of this very important economic species. But when the grass series is put right side up, with the bamboos

at the bottom and Indian Corn at the top, the problem of relationship and origin takes on a very different aspect from what it had before.

Just as the grass series was entirely upside down so also was the Equisetum series in practically all modern treatments. These arrangements came down from botanists who neither believed in any evolutionary process nor had any definite conception of how to evaluate simple and complex reaction systems properly. Thus *E. arvense* L. was at the base of the series and when it was discovered that its gametophytes were more or less unisexual, the conclusion was immediately drawn that all Equiseta have unisexual gametophytes. But it has been found to be contrary to the facts. Now when the phyletic series is properly arranged, in accordance with both the evidence from paleobotany and the comparative study of the reaction systems of the living species, *E. arvense* comes out at the end of the line and its unisexuality appears as a final step leading toward the higher heterosporous level.

The same kind of taxonomic confusion arises when such a genus as Onoclea is placed at the base of the Polypodiaceae, as is still commonly the practice. When a comparative study of its potentialities is made, it stands out as one of the most complicated of ferns. Now just as in Equisetum, it is found that Onoclea has unisexual gametophytes and has thus advanced decidedly toward the condition of the heterosporous plants, a flat contradiction of its supposed position at the base of the Polypodiaceae.

When taxonomy is taught to the more advanced students from the phylogenetic point of view it never fails to arouse a most profound interest and curiosity. After all has been said, taxonomy is still the real study of plants. Taxonomy is the central ring of the main circus-tent of botany; other aspects of the subject are the side rings and the side shows. So whenever taxonomy is neglected botany must suffer severe loss in its standing as a fundamental science. It is therefore important that both those who practice taxonomy and those who teach it consider methods of procedure most carefully and hold fast that which is good.

SOME NEW SPECIES OF PARABOLOCRATUS (HOMOPTERA, CICADELLIDAE)

DWIGHT M. DE LONG
Ohio State University

Parabolocratus continuus n. sp.

Resembling *viridis* in general appearance but with ventral margin of male pygofer not notched. Length, ♂, 6 mm.

Vertex rounded at apex a little more than half as long as basal width between eyes, about three-fourths as long in male as pronotum. Face convexly rounded, not strongly inflated.

Color dull green tinged with brownish, a dark line just beneath margin of vertex.

Male valve short and broad, plates as long as combined basal width, concavely narrowed to rounded apices. Pygofers exceeding plates by one-third their length, ventral margins not notched, concavely rounded at apex to strongly produced dorso-caudal portion. Body of oedagus short, appearing very slender in ventral aspect. Broad in lateral view, not enlarged at apex, a lateral branch either side arising before apex.

Holotype male, Farewell Creek, Saskatchewan, Canada. Male paratypes, Yellowstone National Park, Wyoming, July 4, 1930.

Parabolocratus terminus n. sp.

Resembling *viridis* in size and form, but vertex shorter and male pygofers broad, rounded at apex. Length, ♂, 6 mm.

Vertex rather broadly rounded, about two-thirds as long as basal width between eyes, a little shorter in male than pronotum.

Color green washed with yellow, a black line below margin of vertex.

Male valve concealed, plates longer than combined basal width, tapered to bluntly pointed apices. Pygofers exceeding plates by one-third their length, apices broadly rounded, ventral caudal margin more roundedly produced, ventral margins without notch. Oedagus broad at base, tapered to a pair of apical processes. Dorsal portion bearing a broad, short tooth one-third the distance from base.

Holotype male, Capa, S. D., September 24, 1920 (Severin).

Parabolocratus inflatus n. sp.

Resembling *major* but vertex much shorter and with pygofers rounded apically and produced at middle caudally. Length, ♂, 5.5 mm.; ♀, 7.5 mm.

Vertex broadly rounded, about four-fifths as long as wide between eyes in male and as long as pronotum. Vertex concave, curved upward at apex, face strongly inflated. Elytra in female exposing last segment and ovipositor.

Color green washed with yellow, a dark brown line beneath margin of vertex.

Genitalia: Female last ventral segment roundedly produced. Male valve short, narrower than plates which are one-fifth longer than combined basal width, concavely tapered to pointed apices. Pygofers almost one-third longer than plates, apices roundedly produced at middle of caudal margin, ventral margin concavely rounded, not notched. Oedagus short, in lateral view broad, in ventral view slender, tapered with a process arising laterally either side just before apex.

Holotype male, allotype female and female paratypes, Yellowstone National Park, Wyoming, July 4, 1930 (DeLong); female paratypes Stanley Basin, Idaho, August 3, 1930 (DeLong).

Parabolocratus constrictus n. sp.

An elongate, narrow species resembling *flavidus*, but with vertex more produced, narrowed just before eyes and with apex rather broadly rounded. Length, ♀, 8 mm.

Vertex longer than width between eyes, concavely narrow just before eyes, apical half convexly rounded to broad, rounded apex; longer than pronotum, margin thin, face in profile slightly convex.

Color green tinged with yellow.

Genitalia: Female last ventral segment almost truncate with median fourth produced into a bluntly pointed tooth.

Holotype female and female paratypes, Miami, Florida, April 4 to 14, 1921 (DeLong).

This species can easily be separated by the elongated head and constricted vertex just before eyes.

Parabolocratus elongatus n. sp.

Form and general appearance of *grandis* but much longer with a longer vertex which is conspicuously convexly rounded between lateral margins; length, ♀, 10–11.5 mm.

Vertex one-fourth longer on middle than basal width between eyes, one-half longer than pronotum, convexly rounded on dorsal surface. Elytra short, exposing the last four or five abdominal segments. Face rather strongly inflated.

Color yellowish tinged with green, veins of elytra green.

Genitalia: Female last ventral segment roundedly produced.

Holotype female and paratype female, Interior, S. D., August 28, 1922 (Severin); paratype female, Martin, S. D., September 3, 1923 (Severin).

This is the largest species of the genus which has been described to date and can be distinguished from most of the other species by the very short elytra.

Parabolocratus rotundus n. sp.

Resembling *major* in form and appearance but with a broadly rounded male pygofer. Length, ♂, 7 mm.

Male vertex one-half wider than median length, a little longer than pronotum. Elytra exposing only the pygofers of the abdomen. Face strongly inflated.

Color greenish without definite markings.

Genitalia: Male plates about one-half longer than combined basal width, not quite as long as pygofers which are broadly rounded posteriorly and without a preapical notch on ventral margin. Oedagus stout, in lateral view decidedly narrowed before apex which is expanded and bears a rather long stout lateral process on either side of expanded portion before apex.

The rounded pygofers will immediately separate it from any other species of the genus.

Holotype male, Madison, Wisconsin, September 2, 1916 (DeLong). Paratype males same locality and date, Castalia, Ohio, July 28, 1917 (DeLong); Beach, Illinois, August 7, 1935 (DeLong and Ross); Beach, Illinois, July 25, 1934 (Frison and DeLong) and Des Plaines, Illinois, September 18, 1935 (DeLong and Ross).

How a Physicist Thinks

During recent years, there has been considerable discussion of philosophical questions raised by the new physics, particularly in its statistical, quantum, and relativistic aspects. Both physicists and philosophers have had their say, and considerable diversity of opinion exists. The book "On Understanding Physics," by W. H. Watson, Assistant Professor of Physics at McGill University, is an important contribution toward clear thinking on "natural philosophy." A few sentences from the introduction and the first chapter will serve to indicate Watson's approach.

"In maintaining that it is necessary . . . to show the limits of achievement to be expected in philosophy, one is certain to incur reproof at the hands of not a few professional philosophers. It may seem an impertinence on my part to write boldly on matters which some of my philosophical friends wish to preserve intact in their traditional muddle. The great philosophers of the past . . . would be appalled at the thought that they had produced an indestructible cud for academic rumination." "The primary concern of philosophy is with the logic of ordinary language. . . . Perhaps the most important function of the philosopher in science is to remove the difficulties of the learner, either of entirely new theory or of the older parts of the subject which often present so many puzzles to teacher and student. In this connection he can do good work by discrediting ingenious but unnecessary theories which are designed by their authors to surmount contradictions and serve merely to hide confusion of thought by their very cleverness." "Problems set by a sense of unclearness are not solved, but removed when the source of confusion of thought has been discovered." "Authority in philosophy is the authority of clear statement as opposed to muddled statement, of clear thought as opposed to intellectual puzzle."

Although this book is intended primarily for readers familiar with physics, the discussion should prove illuminating to scientists in general. The few technical details of physics to which the author refers are used simply as illustrations. This book is not light reading—no penetrating discussion of fundamental problems can be—but the author's lively style and his intolerance of nonsense reward the reader with frequent flashes of insight.—*Harold P. Knauss.*

On Understanding Physics, by W. H. Watson. xii + 146 pp. London, Cambridge University Press; in New York, The Macmillan Co., 1938.

NEW TEXAN FULGORIDAE[1] (HOMOPTERA)

JOHN S. CALDWELL
Ohio State University

Cixius chisosus n. sp.

Length 6 mm. Resembling *apicatus* Fowler in form, marking, and coloration of elytra but with vertex extending beyond the eyes as in *flavo-brunneus*.

Vertex deeply excavate caudad, obtusely angled cephalad, less than twice as wide as median length. Face in profile evenly convex. Male pygofers with deep narrow opening; median projection short, pointed. Styles slender throughout, appearing as high-heeled rather long-toed boots. Dorsal membrane long, narrow, recurved into a broadened scoop.

Pale tawny throughout. Elytra not banded but with apices brokenly and heavily darkened.

Male holotype, Chisos Mts., Texas, VII–9–36.

Cixius knulli n. sp.

Length of male, 5.5 mm.; female, 6.2 mm. Resembling *chisosus* except for darker appearance and banded elytra.

Male pygofers with shallower notch than *chisosus* and the sides more oblique; median projection short, rounded. Styles excavate basally with broad projections meeting at midlength; the apices broad, flexed outward, slightly recurved. Dorsal membrane extremely long, narrow, scarcely broadened apically with the apex reflexed. Female ovipositor long and slender.

Head and body tawny. Elytra yellowish with a broad transverse band basally and across the middle; apices extremely and solidly darkened.

Male holotype, female allotype, and paratypes from Davis Mts., Texas, VIII–21–36 and one paratype, VI–2–37.

The writer names this species in honor of his friend, Dr. Josef N. Knull.

Oliarus nigravittus n. sp.

Length 8 mm.; width 3 mm. Resembling *sonoitus* Ball in size and form but lighter in general color and the elytra has a longitudinal stripe.

Vertex as broad as long; median carina present for full length. Face light brown; profile more curved than *aridus* Ball.

Male pygofers deeply and broadly notched, truncate laterally; median projection with slender apex. Styles of same form and appearance as in *pima* Kirk.

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[1]Types are in the Ohio State Collection. All 1936 material was collected by Dr. J. N. Knull, and the 1937 material by both Dr. and Mrs. Knull.

Vertex, face, and median tablet of mesonotum tawny, rest of body blackish. Elytra milky with a sub-basal, narrow, black band not reaching costal margin but continued very narrowly caudad along commissural margin and terminating at the anal vein. Cross veins and furcation of longitudinal veins with black spots.

Male holotype, Uvalde, Texas, VIII–4–37. Paratype, V–23–35.

Oliarus lobatus n. sp.

Length of male, 7 mm.; female, 8.2 mm. Somewhat resembling *pima* Kirk in general appearance.

Vertex longer than broad; lateral margins elevated; median carina present for basal third; caudal margin deeply notched. Frons much narrowed between eyes, about equal in length to clypeus. Mesonotum distinctly five carinae.

Male pygofers evenly, obliquely truncate laterally; ventral opening deep, broad; median projection long, broad, suddenly narrowed apically. Styles much longer than pygofers; apical portion greatly enlarged producing a large, flat, lateral lobe. Dorsal membrane broadly notched apically with a pointed projection on either side of notch.

General color blackish fuscous. Frons darker than clypeus. Forewing whitish-hyaline in both sexes; black punctations on veins very large; infuscation of cross-veins in female very broad, sometimes fused together.

Male holotype, Davis Mts., Texas, VIII–36; female allotype, Davis Mts., Texas, VI–36; paratypes, Davis Mts., Texas, and Hauchauca Mts., Ariz., 1936 and 1937.

Oecleus bilineatus n. sp.

Length of male, 4.5 mm.; female, 5 mm. Resembling *decens* Stål by having the vertex closed caudad and approaching *campestris* Ball in cephalic width of vertex but differing from both in elytra structure and color and in having the mesonotum black with two yellow stripes.

Vertex triangular, exceeding eyes by half its width; in profile about right angled with face which is angled in front of the eyes. Elytra appearing long, narrow, hyaline; commissure twice interrupted with black; veins dark brown, darkening apically, feebly pustulate; costal vein scarcely thickened; nodal cell at least twice as long as broad.

Black throughout; carinae of front, vertex, and pronotum light; mesonotum with intermediate carinae straw yellow.

Female holotype and paratype, and male allotype from Davis Mts., Texas, VII–6–36.

Acanalonia hadesensis n. sp.

Length of male, 3.9 mm.; female, 4.7 mm.; forewing of male, 3.5 mm.; female, 4.4 mm.; width of forewing of male, 2.6 mm.; female, 3.2 mm.

Head scarcely produced beyond eyes; vertex equal to or less than length of pronotum, caudal margin concave, lateral margins slightly divergent; front upright with lateral margins gently bulged basally, median carina prominent. Forewing with costal margin strongly

rounded, apical margin gently convex; reticulations scarcely visible; longitudinal veins with few branches. Last ventral segment of female with a deep, broad, semicircular notch.

Head, thorax, legs, and abdomen straw yellow; forewings pale green deepening in color apically.

Female holotype, male allotype, Devil's River, Texas, VII–2–36.

Flatoides fecalfuscus n. sp.

Length of male, 10 mm.; female, 11 mm. Slightly darker in appearance than *fuscus* Van Duzee and differentiated by the presence of a single preapical spine on the hind tibiae.

Vertex broader than long, rounded cephalad. Frons emarginate apically. Clypeus little longer than broad, flat. First and second antennal segments about equal. Hind tibiae with one spine before apex.

Last ventral segment of male broadly but shallowly excavate caudad. Styles contacting for basal third thence divergent to apex, these margins gently sinuate; apices each with one large spine projecting inward; whole style much shorter than in *fuscus*. Dorsal membrane long, narrow, recurved.

Female with last and penultimate segments deeply and almost squarely notched. Pygofers short, broadly rounded, with heavy teeth. Anal segment long, very broad.

Dirty grey throughout with vein darkening to blackish.

Male holotype, Davis Mts., Texas, VIII–2–37; female allotype, Davis Mts., Texas, VI–14–36, and paratypes from the Davis and Chisos Mts., Texas, and Hauchauca Mts., Arizona.

An Intimate Glimpse of a Naturalist

Edward Wilson is probably best known to people in this country as a South Polar explorer, one of the outstanding men in the expeditions led by Captain Scott. This book tells not only of his two expeditions to the South Pole with Captain Scott, but also of his earlier life.

The character and ability of Wilson are well summed up by one of his friends (p. 213): "Here was an artist of first-rate ability as to technique, who drew only truth, and refused to let his imagination guide his pencil. . . . He was a passionate lover of birds, yet could steel himself to kill them for his scientific work. He was deeply religious, yet had the rare ability to keep his religion out of sight; ceaselessly at work himself, he did not demand an equal energy from his fellows. One had glimpses in him . . . of the missionary yet without that arrogance which presumes to teach others."

This book is made up largely of Wilson's diaries, letters, and notes, and of comments about him by his friends. It is illustrated with 17 color plates and 50 drawings in black and white, covering a variety of subjects, all by Wilson. The twelve chapters cover his life from his first diaries, his life in medical school, his travels in Norway and Switzerland, his work in England, and his two South Polar expeditions.

The book gives a vivid impression of this charming and versatile naturalist. The chapters on the polar expeditions are particularly fascinating. The book is interesting, informative, and inspirational, and should appeal to anyone interested in the biographies of naturalists.—*D. J. Borror.*

Edward Wilson: Nature Lover, by George Seaver. xi+221 pp. New York, E. P. Dutton & Co., Inc. $3.00.

ADDITIONS TO THE OHIO LIST OF DRAGONFLIES (ODONATA)

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In my annotated list of the dragonflies of Ohio[1] 127 species were recorded. During 1937 two species not previously recorded for the state were collected, bringing the total to 129. These two species are as follows:

128. *Macromia pacifica* Hagen. 1 ♀, August 9, 1937, J. Fred Williams. This specimen was taken from the radiator of an automobile, which had picked it up while going from Indian Lake to Columbus. This insect was probably picked up by the automobile in Logan County. This species is primarily a western species, but has been reported as far east as Indiana.

129. *Enallagma basidens* Calvert. 7 ♂ and 4 ♀, June 26, 1937, and 2 ♂, May 30, 1938, by D. J. Borror, at a gravel pit pool about two miles southeast of Germantown, in Montgomery County; 16 ♂ and 15 ♀, August 21, 1937, by D. J. Borror, at a gravel pit pool about one mile north of Miamiville, in Clermont County. It is of considerable interest that this species should be taken in southwestern Ohio, as it was described from Texas and up until a few years ago was known only from the southwestern part of the United States. In 1929 Mr. B. Elwood Montgomery took it in Indiana,[2] and he reports[3] that since then it has become more abundant in Indiana. It appears that this species is extending its range northward and eastward.

Since the publication of my annotated list of Ohio dragonflies, a number of new county records have been obtained which extend our knowledge of the distribution of dragonflies in the state. These records are based primarily on the results of five collecting trips: to Hocking Co., June 6, 1937, by Dale W. Jenkins and the writer; to Licking, Coshocton, Tuscarawas, Wayne, and Ashland counties, June 13–15, 1937, by Dale W. Jenkins and the writer; to Montgomery, Warren, and Butler counties, June 26, 1937, by R. Henry Kyle and the writer; to Fayette, Clinton, Brown, Clermont, and Butler counties,

[1]Borror, Donald J. 1937. An annotated list of the dragonflies (Odonata) of Ohio. Ohio Jour. Sci., 37 (3): 185–196.

[2]Montgomery, B. Elwood. 1932. Records of Indiana dragonflies, VI, 1931. Proc. Ind. Acad. Sci., 41: 449–454.

[3]*Id., op. cit.*, 43: 215, 1934; 44: 233, 1935; 46: 207, 1937.

August 21, 1937, by W. Donald Murray and the writer; and to Montgomery Co., May 30, 1938, by R. Henry Kyle and the writer. All material collected on these trips is in the writer's collection.

The sources of the new records obtained other than on the above trips are indicated in each case. The following abbreviations are used: BJ, collected by Dale W. Jenkins and the writer and in the writer's collection; DJB, collected by the writer and in his collection; DWJ, collected by Dale W. Jenkins and in the writer's collection; OES, in the collection of the Ohio Agricultural Experiment Station at Wooster; VEG, collected by Vernon E. Gifford and in his collection. County records in *italics* are based on sight only, with no specimens collected.

The new county records are as follows (the species are numbered as in my 1937 annotated list):

2. *Gomphoides obscura* (Rambur).[4] Hocking.
9. *Gomphus* (*Gomphus*) *exilis* Selys. Wayne (OES).
10. *G.* (*Gomphurus*) *fraternus* (Say). Wayne (OES).
14. *G.* (*Gomphus*) *lividus* Selys. Franklin (BJ), Wayne.
18. *G.* (*Gomphus*) *spicatus* Hagen. Ashland. This record extends the latest date for the capture of the species in Ohio to June 15.
22. *G.* (*Arigomphus*) *villosipes* Selys. Wayne (OES).
24. *Dromogomphus spinosus* Selys. Delaware (BJ).
28. *Basiaeschna janata* (Say). Wayne. This record extends the latest date for the capture of the species in Ohio to June 15.
31. *Anax junius* (Drury). Ashland, Butler, Clermont.
34. *Epiaeschna heros* (Fabricius). Wayne (OES).
36. *Aeshna constricta* Say. Wayne (OES).
38. *A. umbrosa* Walker. Cuyahoga (VEG).
43. *Cordulegaster obliquus* (Say). Hocking, Jackson (DWJ). May 22 to July 15.
44. *Macromia illinoiensis* Walsh. *Licking.*
49. *Epicordulia princeps* (Hagen). Ashland, *Clermont*, *Clinton*, *Montgomery*, Wayne (OES).
50. *Tetragoneuria cynosura* (Say). Ashland, Coshocton, Hocking, Wayne.
54. *Perithemis tenera* (Say). *Butler*, *Clermont*, *Montgomery*, Wayne, (OES).
55. *Celithemis elisa* (Hagen). Clermont, *Montgomery*, Wayne (OES). The Clermont Co. record extends the latest date for the capture of the species in Ohio to August 21.
56. *Celithemis eponina* (Drury). *Clermont.* This record extends the latest date for the occurrence of the species in Ohio to August 21.

[4]This species was erroneously placed in the genus *Negomphoides* in my 1937 list.

62. *Libellula* (*Holotania*) *cyanea* Fabricius. Perry (in the collection of the Ohio State University).

64. *L.* (*H.*) *luctuosa* Burmeister. Ashland, *Butler*, Clermont, Clinton, *Hocking*, Montgomery, Wayne (OES).

65. *L.* (*Plathemis*) *lydia* Drury. Ashland, *Butler*, Wayne.

66. *L.* (*Neotetrum*) *pulchella* Drury. Ashland, Butler, Clermont, *Montgomery*.

68. *L.* (*Eolibellula*) *semifasciata* Burmeister. Wayne.

70. *Sympetrum ambiguum* (Rambur). Butler, Clinton.

73. *S. rubicundulum* (Say). Butler, Montgomery, Wayne (OES). The Montgomery Co. record extends the earliest date for the capture of the species in Ohio to May 30.

78. *Pachydiplax longipennis* (Burmeister). Ashland, Butler, Montgomery, Wayne (OES).

79. *Erythemis simplicicollis* (Say). Ashland, Clermont, Clinton, Fayette, *Montgomery*, Wayne (OES).

80. *Pantala flavescens* (Fabricius). Cuyahoga (VEG).

82. *Trapezostigma carolina* (Linnaeus).[5] *Montgomery*.

83. *Trapezostigma lacerata* (Hagen).[5] *Butler*, Clermont, *Hocking*, *Montgomery*, *Wayne*.

87. *Calopteryx maculatum* (Beauvais). Brown, Butler, Huron (OES), Montgomery, Warren. The Brown Co. record extends the latest date for the capture of the species in Ohio to August 21.

88. *Hetaerina americana* (Fabricius). Brown, Clermont, Montgomery, Warren, Wayne (OES).

95. *Lestes inaequalis* Walsh. Ashland.

96. *L. rectangularis* Say. Ashland, Butler, Clinton, Fayette, Hocking, Montgomery, Tuscarawas, Wayne (OES).

97. *L. uncatus* Kirby. Ashland, Wayne.

98. *L. unguiculatus* Hagen. Butler, Lucas (collected by Joe Bailey, and in the collection of the Museum of Zoology at Ann Arbor), Wayne (OES).

100. *Argia apicalis* (Say). Clermont, Fayette, Tuscarawas, Warren.

102. *A. moesta* (Hagen). Brown, Clermont, Montgomery, Vinton (DJB), Warren.

103. *A. sedula* (Hagen). Brown, Clermont.

104. *A. tibialis* (Rambur). Coshocton, Tuscarawas, Wayne.

105. *A. violacea* (Hagen). Butler, Clermont, Montgomery, Warren.

109. *Chromagrion conditum* (Hagen). Hocking.

110. *Enallagma antennatum* (Say). Montgomery.

113. *E. carunculatum* Morse. Wayne (OES).

114. *E. civile* (Hagen). Clermont, Montgomery.

118. *E. exsulans* (Hagen). Brown, Clermont, Coshocton, Warren, Wayne.

119. *E. geminatum* Kellicott. Ashland, Clermont, Montgomery.

120. *E. hageni* (Walsh). Ashland.

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[5]Cowley, J. 1935. Nomenclature of Odonata: three generic names of Hagen. The Entomologist, 68: 283–284. According to Cowley, the genus *Tramea* Hagen, 1861, must be replaced by *Trapezostigma* Hagen, 1849.

121. *E. signatum* (Hagen). Ashland, Clermont, Montgomery, Wayne (OES).
123. *E. vesperum* Calvert. Ashland.
124. *Ischnura posita* (Hagen). Ashland.
126. *I. verticalis* (Say). Ashland, Brown, Clermont, Montgomery, Warren.
127. *Anomalagrion hastatum* (Say). Montgomery.

The Physical Universe

Man's Physical Universe, by Arthur Talbot Bawden, is a book which has been prepared as a text for survey courses in physical sciences. How well this problem has been coped with can perhaps best be determined by actual use of the book in such a course, but in this reviewer's opinion the problem still remains unsolved. Certain chapters of this book may be regarded as suitable for a course in high school general science, but for students of college calibre it would seem to constitute a waste of valuable time. A great many inaccuracies may be pointed out throughout the book; for example, on page 62, Yerkes Observatory is placed at Madison Bay rather than at Williams Bay where it is actually located; on page 150 Leyden, a Dutch city of 70,000 population, is depicted as an obscure German village. On page 424, in fig. 245, is shown how parallel beams of light are acted upon by convex and concave lenses. No discussion whatever follows concerning the points to which the light converges in the first case nor the point from which the light appears to diverge in the second case. The infra-red rays of the spectrum are discussed on page 443 and one is left with the impression that it is just another region of the spectrum where special photographic plates are required, whereas what is actually the case is that only a very narrow region is photographable (from .8μ to 1.1μ) while the remaining region (from 1.1μ to 300μ) must be investigated bolometrically. On page 605 occurs a discussion of quantum theory. The word formulas has been used instead of what probably should have been formalism. Werner Heisenber is portrayed as an abstract mathematician rather than a cracking good physicist and finally Schrödinger theory is represented as a manifestation of the theory of relativity—both statements are notoriously incorrect. One is indeed left with the impression that the author is poorly informed concerning his subject matter. The book can really not be recommended for the purpose for which it is intended.

—*H. H. Nielsen.*

Man's Physical Universe, by Arthur Talbot Bawden. xvii+812 pp. New York, The Macmillan Co., 1937. $3.50.

The Mathematics of Einstein's Theory of Gravitation

When Einstein developed his relativity theory of gravitation, he found the necessary mathematics ready to hand in Riemann's geometry. This geometry was a direct extension of the differential geometry of curves and surfaces in three-dimensional space to an arbitrarily curved space with any number of dimensions. The extension of the notations and methods of vector analysis to Riemannian geometry gave the tensor notation and absolute differential calculus of Ricci and Levi-Civita. In fact the paths of particles in Einstein's theory are lines of stationary length in a four-dimensional space-time homogeneous with respect to the Ricci tensor. Weatherburn's book is an introduction both to the tensor calculus and to Riemannian geometry. It is written in the same clear style as his books on vector analysis and differential geometry, and will form an admirable introduction either to advanced differential geometry or to the theory of relativity.—*L. H. Thomas.*

An Introduction to Riemannian Geometry and the Tensor Calculus, by C. E. Weatherburn. xii+191 pp. Cambridge, at The University Press; New York, The Macmillan Company, 1938. $3.75.

SPIDERS AND INSECTS FOUND ASSOCIATED WITH SWEET CORN, WITH NOTES ON THE FOOD AND HABITS OF SOME SPECIES

II. Ephemerida, Lepidoptera, Neuroptera, Odonata, Orthoptera, Thysanoptera, and Trichoptera

RAY THOMAS EVERLY
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EPHEMERIDA

This order is represented by only one species, unquestionably a visitor brought into the field by winds from the direction of the lake.

Ephemeridae

Hexagenia bilineata Say. Three specimens taken July 16 to August 8. This is the species common along Lake Erie and known to the residents of this region as "June-bugs" or "Canadian Soldiers." One old gentleman of this locality advanced the naive suggestion that this insect "hatched from infertile fish eggs." During the summer months, when the wind is blowing off the lake, these insects are present in such numbers as to make driving extremely hazardous. Street lamps and lighted windows may be completely covered with a layer of these insects, and lighted advertisements will be entirely hidden.

Determination of these specimens was made by Mr. A. N. Caudell.

LEPIDOPTERA

This order is quite well represented. However, as many of the adults were difficult to capture, with time and proper collecting equipment, the number of species in this order could have been greatly extended. Determinations were made by Mr. F. H. Benjamin, Mr. August Busck, Mr. C. Heinrich, and Mr. John Thomas.

Arctiidae

Diacrisia virginica Fab. Two larvae taken on the corn plants July 10 and 12.

Estigmene acraea Dru. One adult taken August 12, and a larva taken on the corn plants July 29.

Geometridae

Geometridae sp. Four larvae taken on the corn plants in late August.

Pleuroprucha insularia Gn. Two adults taken August 1 and 12.

Gelechidae

Aristotelia (*Chrysopora*) *hermanella* Fabr. Two adults taken July 13 and 17.

Hesperidae

Pholisera catullus (Fabr.). One adult taken July 20.

Talides themistocles (Lat.). One adult taken August 5.

Lymnadidae

Anosia plexippus L. Observed resting upon a corn plant on July 16. The presence of this species in the corn field was undoubtedly due to the milkweed present in the field. Larvae of this species were often observed feeding upon the leaves of milkweed.

Noctuidae

Acronycta oblinita (S. & A.). A larvae taken upon the corn plant in late August.

Caenurgia erecta Gr. Adult taken on July 15.

Ceramica picta Harris. "A pale larvae" taken on corn plant on July 17.

Heliothis obsoleta Fab. Adults taken on August 3, larvae on leaves of corn in late August.

The adults of this species were first observed flying in large numbers on August 5 among the corn plants when disturbed. The larvae were numerous in the ears of late sweet corn.

Lithacodia carneola Gn. One adult taken on July 31.

Noctuidae sp. Two larvae taken July 9 and August 2, and one pupae taken in late August.

Noctuidae (*Cirphus* group). One larvae taken upon the corn plant August 15.

Plusia sp. One larva and a cocoon and pupa taken on the corn plant in late August.

A larva of this genus was taken as the prey of *Sphex urnarius* (Daml.), (Hymenoptera-Sphecidae).

Prodenia sp. Early stage larva taken upon the corn plant July 10.

Prodenia ornithogalli Gn. One larva taken upon the corn plant in late August.

Nymphalidae

Basilarchia astyanax Fab. Observed resting upon the corn plants on July 5 and August 5.

Basilarchia disippus Godart. Observed flying in the field on July 8.

Polygonia interrogationis Fabr. Adult taken on August 6.

Other specimens of the genus were observed flying among the corn plants throughout the season, but it is impossible to state whether or not they were the same species.

Vanessa altanta L. One adult taken on August 9. Observed feeding upon the exudations from a corn borer opening on August 9. The species was a frequent visitor among the corn.

Vanessa cardui L. Adult taken on August 8. Pupa collected on corn plant in late August.

Vanessa virginiensis Dru. One adult taken on August 14.

Pieridae

Pieris rapae L. One adult taken July 20.

This species was common throughout the season, undoubtedly due to the fact that most of the cabbage fields in the near vicinity were unharvested due to prevailing low prices. The butterflies were so numerous about the cabbage fields that the air above had the appearance of a snow storm.

Pyralidae

Pyralidae sp. (*Pyraustinae*). One larva taken upon the corn in late August.

Argyria nivalis Dru. One adult taken July 13.

Nomophila noctuella D. & S. One adult taken July 20.

Pyrausta nubilalis Hbn.

The adults of this species were observed in the field in numbers from July 7 to 18, and again in much smaller numbers on August 10. A pupa was found during the dissections, on August 2 and two more were found on August 5. Two larvae were taken, one as the prey of *Glischrochilus quadrisignatus* Say (Coleoptera-Nitidulidae), on July 25. This larva was still partly in a tunnel. The other larva was being dragged away by an individual of the species *Prenolepis imparis* (Say), (Hymenoptera-Formicidae).

Loxostege similalis Gn. One adult taken August 12.

Tortricidae

Grapholitha interstinctiana Clem. One adult taken August 12.

Yponomeutidae

Glyphipteryx impigritella Clem. One adult taken July 28.

NEUROPTERA

Chrysopidae

These insects were very numerous in the corn field. Their stalked eggs were observed upon the corn plants throughout the season. Mr. Ralph Mathes reported observing an undetermined larva feeding upon a corn borer egg mass upon a corn leaf. Determinations of the following species were made by Mr. A. N. Caudell.

Chrysopa chi Fitch. Five specimens taken July 9 to August 8.

Chrysopa chlorophana Burm. One specimen taken August 8.

Chrysopa ploribunda Fitch. Three specimens taken July 29 to August 7.

Myrmeleontidae

Adults of this family were observed frequently during the season. Even though not strong flyers, they were difficult of approach and only one specimen was taken. This was determined by Mr. A. N. Caudell.

Clathroneuria sp. One specimen taken July 18.

ODONATA

Ischuridae

Several species of this group were observed in the field at different times during the season, but only one specimen was captured. Mr. D. A. Borer made the determination.

Ischnura verticalis Say. One female taken upon the corn plant on August 8.

Libuellidae

No specimens of this family were collected, as they are exceptionally alert and fast on the wing. They were observed throughout the season flying and feeding above the corn, and were seen occasionally to rest upon the tassels and upper leaves of the corn plants.

ORTHOPTERA

This order was represented in the corn field chiefly by the grasshoppers and crickets. None were observed feeding upon the corn plants, although many were frequently seen resting upon the corn leaves. All determinations were made by Mr. E. S. Thomas.

Acrididae

Dissoteria carolina (L.). One male taken on July 25 and two females taken July 29 and August 3. A III instar nymph was taken July 9.

The above species was very abundant on the ground of the roadways between the plots of corn and were observed occasionally among the corn plants. The first adults were seen on July 18 and were very common by July 26. On July 29 two specimens, the sex unknown, were observed to alight beside each other facing in opposite directions. After a few moments they simultaneously raised their posterior pairs of legs into the air four times, very slowly, the angle formed by the femur and tibia while at rest, was retained when the legs were raised. They then flew in opposite directions.

Melanoplus femur-rubrum (DeG.). IV instar male taken August 7.

Melanoplus mexicanus mexicanus (Saus.). Two females taken July 11 and 18, a V instar male taken July 9, and a V instar female taken July 31.

Blattidae

Parcoblatta uhleriana (Saus.). One adult female taken on the corn plant July 22.

Gryllidae

Gryllus assimilis Fab. Four adult females taken July 17 to late August. One V instar female collected in late August.

Nemobius fasciatus subsp.? (DeG.). One pair taken August 5 and 14, a V instar male on August 1, a III instar nymph on August 14, and a III instar female taken July 31.

The specimens of the two above species were very common on the ground beneath corn and weed debris.

Oecanthus nigricornis nigricornis F. Walker. One adult female taken August 14 and a III instar male taken July 17.

Tettigonidae

Conocephalus fasciatus subsp.? (DeG.). One male, "undoubtedly a migrant," taken on August 7.

Orchelium vulgare Harris. V instar male taken July 28, IV instar male July 16, and IV instar female on July 19.

THYSANOPTERA

Two families of this order were collected in the cornfield. Determinations were made by Mr. Dudley Moulton.

Aeleothripidae

Aeliothrips sp. One specimen taken July 11 on the corn plant.

Thripidae

Anaphothrips striatus Osb. The "oat-bug" was very abundant about the time the oats in adjoining fields were cut, and were very annoying and irritating when crawling upon a person's skin.

TRICHOPTERA

This order was represented by one small specimen which Mr. A. N. Caudell stated "a small caddis-fly. I am unable to name this."

Bird Flocks and the Breeding Cycle

The author spent two years on Priest Island, off the northwest coast of Scotland, studying social behavior in breeding flocks of gulls and other sea birds. This book is a report of his observations, primarily as they relate to the theory that the gregarious habit in these birds has an important influence on their mating and nesting activities.

While the onset of the reproductive condition in birds is influenced to a considerable extent by external physical factors and inherent reproductive rhythms, the author contends that the final steps in the reproductive cycle, mating and nesting, are in these gregarious birds definitely influenced by the contacts of the individual bird with others. These contacts in the case of gulls are described in considerable detail. The author shows that in many species of birds there is a minimum population density for reproductive activities, below which reproduction will not take place.

The chapter headings are indicative of the scope of the book: I, Sexual Periodicity; II and III, Breeding Flocks of Gulls; IV, Communal Courtship; V, Conclusion; Appendix, List of Types of Display in Gulls.

This book should be of interest not only to anyone interested in birds but to anyone interested in animal sociology or in the factors affecting the reproductive cycle. The American bird student need not worry about the interest of the book because it concerns British species; the same or closely related species occur along the American coasts, and their social behavior is undoubtedly very similar to that of the species described. The author of this book has made a definite contribution to our knowledge of avian sociology and physiology, which should stimulate further observations along similar lines.—*D. J. Borror.*

Bird Flocks and the Breeding Cycle. A contribution to the study of avian sociality, by F. Fraser Darling. Cambridge, at the University Press; New York, The Macmillan Co., 1938. $1.75.

THE ANATOMY AND HISTOLOGY OF THE ALIMENTARY SYSTEM OF THE HARLEQUIN CABBAGE BUG, MURGANTIA HISTRIONICA HAHN. (HEMIPTERA, PENTATOMIDAE)[1]

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The Harlequin cabbage bug, *Murgantia histrionica* Hahn, is a common and frequently very destructive pest of cruciferous plants in the southern part of the United States and south at least as far as Central America. Although it occurs, occasionally, as far north as the Canadian shores of Lake Erie, it is apparently unable to withstand ordinary winters in latitudes much farther north than the fortieth parallel (22)[3] but is thought to migrate north from its overwintering habitats each season.

METHODS

Specimens used in studies of the gross anatomy of the alimentary system were dissected *in vitro* under 1-normal saline solution and inasmuch as material was abundant specimens so used were discarded.

Tissues to be used for histological preparations were taken both from fresh material and from preserved specimens. Both methods proved satisfactory. The preservative or fixative, in all cases, was Kahle's solution (14). All histological preparations were made by the paraffin method and cut on a rotary microtome. The various structures were sectioned individually and in addition several series of sections were cut, in different planes, from the viscera *in toto* and still others from entire individuals, taken and preserved in the teneral condition. The method described by Awati (1) for softening hardened, chitinized structures was not discovered by the writer in time for use in this study.

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[1]Contribution from the Department of Zoology and Entomology of the Ohio State University, Number 113.

[2]The writer wishes to express his appreciation to Dr. C. H. Kennedy for his criticisms and suggestions during the course of this study and also to those of his colleagues who aided in securing material and in various other ways.

[3]Numbers in parentheses refer to the bibliography, page 324.

Haemalum was used as a nuclear stain and Fast Green, F. C. F. for cell walls and cytoplasm. Cell walls were not uniformly well stained and it is recommended that other stain combinations be added or that, if possible, a triple staining technique be used to obviate this deficiency.

Drawings, with the exception of Figures 1 and 2, were made with the aid of a projection microscope, the finer details being filled in, freehand, during observation of the tissues under high power or oil immersion objectives.

GROSS ANATOMY OF THE ALIMENTARY CANAL

At least nine distinct regions are recognizable in the alimentary canal. Three are stomodeal, three ventricular and three proctodeal. It will be noted that in this, as in many phytophagous species of Hemiptera, the ventriculus comprises by far the largest part of the alimentary canal.

THE STOMODAEUM

The *functional mouth* is a short, curved, chitinous tube, lying in the extreme anterior portion of the head capsule and opening, at its posterior end, into the *cibarium* or sucking pump. The cibarium extends nearly to the posterior margin of the head capsule, giving way, posteriad of the brain, to the *oesophagus* which extends just into the thorax (Fig. 2, Oes). In cross-section the cibarium (Fig. 3) appears V-shaped, is firmly embedded in the hypopharynx and the various parts of the tentorium and is connected to the dorsal wall of the head by its dilator muscles.

Both the functional mouth and the cibarium are preoral structures. Various authors have referred to the cibarium as the pharynx but Weber (29) and Snodgrass (28) point out that the true pharynx lies posterior to the sucking pump. In the present species the pharynx is almost obliterated and the extreme modification of the parts makes it impossible to limit, precisely, the various preoral and stomodeal structures.

THE VENTRICULUS

The first stomach or *anterior portion of the ventriculus* (Fig. 2, 1 Vent) is thin walled and of comparatively large diameter. It bears a prominent, dorsal, median raphe, several irregular lateral folds, but no ventral raphe. During the dissection of the insect *in vitro*, peristaltic waves were frequently observed in this region. The second stomach or *mesial portion of the ventriculus* (Fig. 2, 2 Vent) is a smooth walled tube, dilated, in active specimens, near its posterior end, to form what may be a storage space somewhat analagous to the crop of other insects. In hibernating specimens this dilatation was much less pronounced and in contrast to that of active specimens contained little or no food residue. Histological examination indicates that it should not be considered a separate division of the ventriculus. The third stomach or

posterior portion of the ventriculus (Fig. 2, 3 Vent) is remarkable in that it bears four rows of rather disc-like caeca. These will be more fully discussed in connection with their histology.

THE PROCTODAEUM

The proctodaeum, like the stomodaeum, is very short. It consists of a small caliber *anterior intestine* (Fig. 1, Ant Int), a large, thin walled *posterior intestine* (Fig. 2, Rect Sac) or rectal sac and a narrow *anal canal*, (Fig. 14) the latter contained within the anal capsule. During dissection the posterior intestine was occasionally observed to contract suddenly, as if expelling its clear, liquid contents, following which action it slowly regained its former, distended appearance.

Arising from the ventral wall of the anterior intestine is a pouch (Fig. 1, Fig. 2, Ileum?) into which the four Malpighian tubules empty. Breakey (7) reports two such diverticula in *Anasa tristis*, with two Malpighian tubules emptying into each one and various similar structures are found in other Hemiptera. Bearing in mind that in most insects the Malpighian tubules empty directly into the variously modified ileum and that in the present species the proctodeaum is so greatly reduced, one is moved to ask whether the diverticulum may not, itself, be an extremely modified ileum.

The Malpighian tubules lie in an apparently but not really tangled mass, dorsal to the posterior portion of the ventriculus, and end blindly. They are shown in the drawings as being cut off near their origins. It is interesting, in view of their mode of origin by evagination from the intestine, that although they are looped upon themselves and each other in almost every conceivable manner they were never found to be knotted or tangled. Their length is considerable, one which was measured by the writer being over twenty-five millimeters long. They are held together in a mass by connective tissue, but in no case were they found to be inserted into the wall of the alimentary canal nor bound by the peritoneal sheath of the alimentary tube.

THE HISTOLOGICAL STRUCTURE OF THE ALIMENTARY CANAL

THE STOMODAEUM

The *cibarium* (Fig. 3) is entirely chitinous and is, according to Snodgrass (28), "truly a preoral structure. . . . Its concave floor is formed by the adoral surface of the base of the hypopharynx, flanked by the suspensorial sclerites of the latter; its roof, or anterior wall, is the epipharyngeal surface of the clypeus." It consists, in the present species, of a thick walled groove which forms the ventral half of a tube, the dorsal half of which is the thin, elastic operculum. Arising from the dorsal mid-line of the operculum is a row of chitinous tendons on which are inserted the dilator muscle fibers. These muscles originate on the clypeus, lateral to the mid-line, so that in cross section of the head capsule they form a V. No other muscles are present in the cibarium. When the dilator muscles of the cibarium are relaxed the operculum is folded into the groove. When these muscles contract, it is raised, forming a canal, rhomboidal in cross section and with greatly

increased capacity. It is by means of the suction thus produced that the insect ingests its liquid food. The return of the operculum to its normal position is effected by its natural elasticity.

Ventrad of the brain the cibarium merges into the greatly reduced *pharynx* which, in turn, opens into the *oesophagus*. Its walls are continuous with the chitinous intima of the oesophagus. This is surrounded by a columnar epithelium by which, apparently, it is secreted. In the same region a well developed band of circular muscles appears, forming a sphincter which, undoubtedly, aids in preventing the anterior movement of food from the ventriculus during the suctorial process. Also, according to Bugnion (4), it pushes the liquid food along its way. Further posteriad a few scattered longitudinal muscle fibers are found entad of the circular layer. The oesophagus, ventriculus and intestine are enveloped in a thin peritoneal sheath which is frequently difficult to demonstrate. There is, however, no question as to its presence.

The oesophageal intima appears to nearly fill the canal formed by the epithelial layer of cells (*vide*, Fig. 4 and Fig. 5). It is projected a short distance into the lumen of the ventriculus (Fig. 5) and may have, in a passive way, some valvular action. The writer was unable to determine whether the intima is composed of a solid mass of very transparent chitin, of intersecting membranes or of chitinous strands. Perhaps some microchemical tests, such as described by Campbell (8) would be of assistance in answering this question.

Just anterior to the stomodeal valve the order of muscle layers of the oesophagus is reversed, the longitudinal muscles coming to lie outside the circular layer. Obviously, however, this reversal does not mark the point of junction of the stomodaeum and the ventriculus, because in none of the specimens studied histologically was there any change in the nature of the epithelium at this point. Besides, the junction is clearly shown at a point further posteriad.

The oesophagus widens slightly at its posterior end and the cells of the epithelium become elongate, extending, slightly, into the lumen of the ventriculus. This may be clearly seen in Figure 5. The juncture of the stomodaeum and ventriculus is marked by the abrupt change in the cells of the epithelial layer from the elongate type just mentioned to the shorter, more regular, but still columnar type characteristic of the entire mesenteron. Both longitudinal and circular muscles are demonstrable in this region but the latter, in particular, are scarce. Hence any valvular function must be accomplished by the pressure of food material in the ventriculus on the projecting tube of oesophageal intima. If this is not sufficient to prevent regurgitation, the action of the sphincter, previously mentioned, provides an adequate supplement.

THE VENTRICULUS

The ventriculus as a whole conforms to the typical histological pattern. It is lined by a layer of epithelial cells, usually columnar in form and resting on a thin basement membrane which is surrounded, in turn, by circular muscles, longitudinal muscles and a peritoneal sheath. Nowhere is there evidence of a peritrophic membrane. Throughout

the ventriculus the free margin of the epithelial cells bears a striated border except during the active secretory phase. Secreting cells were observed only anterior to the dilated portion of the second stomach. Secretion is of the apocrine type, the fluid to be secreted accumulating in the distal end of the cell which becomes distended and is finally pinched off, leaving the rest of the cell intact. The secretion is subsequently released into the lumen of the ventriculus and the cell, after a period of rest, may again become active. Snodgrass (28) describes this as the typical method of secretion in adult insects. As might be expected, no nidi of regenerative cells were observed.

Yung-Tai (31) and others maintain that secretions are in the form of diffusible liquids and that such processes as described above are the discharge of cytoplasmic disintegration products. The present investigations are not of such nature as to throw any light on this question.

The writer has not seen the term *apocrine* used in entomological literature but it is in common use by histologists in the medical profession (21).

The *first stomach* (Vent 1) is thin walled and the musculature is much reduced. It should be noted that the large diameter of this region is not caused by distension. The epithelial cells appear, rather, to be crowded. It is also interesting to observe that in spite of the fact that both longitudinal and circular muscles are comparatively fewer in this region than in any other part of the alimentary canal, this is the only place where peristalsis was seen to occur during dissection.

Malouf (18) states that in *Nezara viridula*, another pentatomid, this region is lined by a chitinous intima and he, therefore, considers it to be a part of the stomodaeum. No trace of a chitinous intima is present in this part of the alimentary canal of *Murgantia* and there can be no question but that in this species it is definitely a part of the ventriculus.

The *second stomach* (Vent 2) is not remarkable anterior to its dilated portion, it being the least specialized part of the entire alimentary canal. It will be observed (Fig. 9) that the epithelial tissue in the enlarged region has been stretched until the cells have assumed a cuboidal in place of a columnar form. Further evidence of distension is the fact that if the bulb is punctured during dissection the contents are forcibly ejected. The dilatation is never obliterated in such cases nor during hibernation, but this may indicate either that the muscles have lost their tonus or that some progress has been made in the evolution of a permanent structure. No sections were made from hibernating specimens so the histological structure of the bulb in its reduced condition is unknown. Posteriorly the columnar form of epithelial cells is resumed.

Nearly to the posterior end of the second stomach there is a slight elongation of the cells of the epithelium, accompanied by a slight concentration of circular muscle fibers (Fig. 10). This suggests the possibility of a valvular action controlling the passage of food or food residues into the third stomach. The presence of such a valve would aid in explaining the pressure apparent in the bulbous region just anterior. The need, if any, for the retention of food or food residues in the second stomach or for the regulation of their passage into the

third stomach must remain unexplained in a purely morphological study. However, the question is interesting and its solution might throw additional light on the function of the gastric caeca of this and related insects.

The *third stomach* (Vent 3) is distinguished by the four rows of caeca which are formed by evagination (12) from the embryonic ventriculus. Each caecum is disc shaped and consists, apparently, of an extremely thin wall of epithelial cells, which are stretched beyond recognition. The nuclei of the epithelium are shown (Nuc Epl) in muscles are found in the caecal walls. Glasgow (12) reports that the Figure 11. No muscles are found in the caecal walls. Glasgow (12) reports that the caeca are filled with specific bacteria which are transmitted from generation to generation through the embryo. These bacteria are said to prevent the infestation of this region of the ventriculus by other forms. This is considered to be beneficial to the insect and Weber (29) terms the caeca, descriptively, *symbionten krypten.* The sectioned material does not show recognizable bacterial forms, but this is undoubtedly a result of the action of the reagents used in the histological preparation of the tissues.

The alimentary canal proper, in this region, is of small caliber. When it is contracted the epithelial cells are columnar but when it is distended they assume a cuboidal form. Both circular and longitudinal muscles are present and lie close to the epithelium. The wall is, therefore, quite compact. The peritoneal membrane is folded around and between the rows but not between the individual caeca and lies very close to the enclosed structures.

THE PYLORUS AND THE PROCTODAEUM

Immediately posterior to the caecal region is found the pylorus, which marks the junction of the ventriculus with the proctodaeum.

The *pyloric valve* (Fig. 12), like the stomodeal valve, is poorly supplied with muscles. It consists of elongated cells of the ventricular epithelium, extending into the lumen of the anterior intestine, the walls of which are folded at this point. The valvular action must be largely dependent on the pressure of the contents of the proctodaeum on the extended walls of the ventricular epithelium. As in the case of the stomodeal valve the function must be the prevention of regurgitation.

The *anterior intestine* is thick walled, the thickness being due, largely, to the extreme length of the columnar epithelial cells. Longitudinal muscles are scarce and circular muscles are almost entirely lacking. There appears to be a layer of connective tissue immediately outside the epithelial layer of cells.

The *diverticulum* into which the Malpighian tubules empty is similar to the anterior intestine in histological structure and the various tissues are continuous. The epithelial cells of the diverticulum, however, are larger and are of the cuboidal type. Figure 12 shows the histological structures of the anterior intestine, the pouch and a Malpighian tubule.

In structure, the *Malpighian tubules* are very simple, appearing in cross section to consist of three or four large cells with large nuclei. The lumen of the tube is lined by a striated border. No muscle layers are present nor could a peritoneal membrane be distinguished.

Two types of cells are found in the epithelium of the posterior intestine or *rectal sac*. The more common type are large and variously shaped and in general have comparatively large nuclei. The others are narrow and crowded, occurring in groups which are irregularly distributed. Figure 15 shows the structure of both types clearly. The writer found no basis on which an attempt to homologise the groups of smaller cells with the rectal pads of other insects might be justified and no indication of their function was apparent.

No longitudinal muscles were to be found in the wall of the rectal sac but there are numerous circular muscles. It has already been noted that these muscles contract, periodically, emptying the sac of its contents. A layer of connective tissue lies between the circular muscle band and the thin peritoneal membrane.

The beginning of the *anal canal* (Fig. 14) is marked by a well-developed group of circular muscles located at the anterior border of the anal capsule and forming an anal sphincter (Fig. 14, M An Sph). It should also be mentioned that no chitinous intima could be discerned lining the proctodaeum anterior to this point. Posteriorly the canal consists simply of an invagination of the body wall as shown. The epithelium or hypodermis of the canal is continuous with the epithelium of the rectal sac.

THE SALIVARY SYSTEM

In *M. histrionica*, as in many other Hemiptera, the salivary system is both prominent anatomically and important in the nutritive processes of the insect. It, therefore, merits especial discussion.

The two salivary glands are unequally bilobed and lie dorsal to the ventriculus in the thorax, the larger and posterior lobes extending into the abdomen. Each principal gland is provided with a filiform accessory gland lying laterad and emptying by means of a long duct which extends into the head capsule, retroverts into the abdomen, is anteverted, undergoes a series of convolutions and finally opens at the juncture of the two lobes of the principal gland. From this point the salivary duct arises and passes directly into the head to unite with its bilateral opposite and empty, finally, into the chamber of the salivary syringe.

The *syringe*, a remarkable force pump, lies in a horizontal position between the arms of the tentorium, just ventrad of the cibarium. Its powerful retractor muscles are inserted on the flattened chitinous rod which is continuous with the piston and probably have their origins on the lateral arms of the tentorium and the ventral wall of the head capsule.

The following discussion is translated from Bugnion and Popoff (5): "In the Hydrocores, the accessory salivary gland serves the purpose of a reservoir, and lies beside the oesophagus, inside the thorax. The secretion of the accessory gland may, depending on the circumstances, enter the principal gland, which then serves as a reservoir, and mix with the secretion of the latter before flowing outside.

"A study of inferior forms (Aphids) shows that the salivary glands of Hemiptera are primitively tri-lobed, two of which remain contiguous while the third is more detached and is elongated.

". . . The ducts, in the Geocores, are also glandular, being secretory as well as conducting organs.

"The salivary glands of the Hemiptera are morphologically labial glands, corresponding to those of the Diptera, Hymenoptera and Orthoptera. They are also homologous with the silk glands of the silkworm, the principal glands corresponding to the gland of Filippi and the accessory gland of the silk gland proper. They arise as diverticula of the stomodaeum, thus being ectodermal in nature. . . .

"The saliva of phytophagous Hemiptera is alkaline in nature and probably has two functions, first, to cause the sap to flow and second, to dissolve the cellulose walls of the host plant cells and perhaps begin the digestion of the starch grains. The efferent salivary duct leads to the excretory canal, not to the pharynx. The digestive action of the saliva, begun outside, is probably continued in the stomach, considerable saliva being drawn up with the sap. In predaceous groups the secretion is toxic."

The walls of the principal glands consist of a single layer of cuboidal epithelial cells. No chitin was observed in the gland proper although the ducts of both the principal and accessory glands are provided with a heavy chitinous lining.

The duct of the accessory gland is inserted, the salivary duct originates and an opening between the two lobes of the principal glands occurs in an isthmus of columnar cells as shown in Figure 16a.

Unfortunately, during the making of histological preparations for the present study, none were made of the accessory salivary gland alone. However, in cross sections of a teneral individual, certain tubes appear which conform almost perfectly to Breakey's (7) description of the accessory gland in *Anasa tristis*. The cells are large, have large, deeply staining nuclei and have the general characteristics of glandular cells. Although none were observed in the actual process of secretion, many appeared to be distended.

The epithelium of the principal gland in no case appeared to be of a secretory nature. The gland is, however, usually filled with a homogeneous material which stains very evenly with Fast Green, F. C. F. In view of all the foregoing evidence the opinion is hazarded that in *M. histrionica* the salivary fluid is secreted chiefly by the accessory gland and that the function of the principal gland is largely that of a reservoir.

The salivary syringe (Fig. 17) is of the usual type. It consists of a heavy chitinous cupula, firmly attached to the tentorium, and a chitinous piston, the two being united by an elastic chitinous diaphragm. The contraction of the retractor muscles of the piston enlarges the cavity of the cupula and permits the saliva to flow in through the afferent duct. When the muscles relax, the piston is returned to its former position by the elasticity of the diaphragm, thus forcing the saliva out through the efferent duct. The entrance of the common salivary duct to the cavity of the cupula is provided with a chitinous flap which acts as a valve and prevents the salivary fluid from being forced backward through the afferent duct during ejaculation. No valve is present in the efferent duct but the walls are apparently elastic and are in apposition except when saliva is being ejected from the syringe.

Neither the efferent salivary duct nor the food canal were traced to their extremities in the beak but Weber (29) and Awati (1) state that in most if not all Hemiptera they remain distinct. The latter paper gives an excellent discussion of the structure and function of the salivary apparatus and the mechanism of suction in *Lygus pabulinus*.

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EXPLANATION OF PLATES

Plate I

Fig. 1. Dorsal aspect of the alimentary system, including the salivary system, *in situ*. Only the proximal portions of the Malpighian tubules are shown.
Fig. 2. Gross anatomy of the alimentary canal. Only the proximal portions of the Malpighian tubules are shown.

Plate II

Fig. 3. Cross-section of the cibarium and its supporting structure.
Fig. 4. Cross-section of the oesophagus.
Fig. 5. Longitudinal section of the oesophageal valve.
Fig. 6. Cross-section of the first stomach.
Fig. 6a. Portion of cross-section of the first stomach, highly magnified.

Plate III

Fig. 7. Longitudinal section of the junction of the first and second stomachs.
Fig. 8. Cross-section of the anterior portion of the second stomach.
Fig. 9. Highly magnified portion of cross-section of the wall of the bulbous portion of the second stomach.
Fig. 10. Longitudinal section of posterior portion of the second stomach, showing the valvular structure occurring just anterior to the caecal region of the ventriculus.

Plate IV

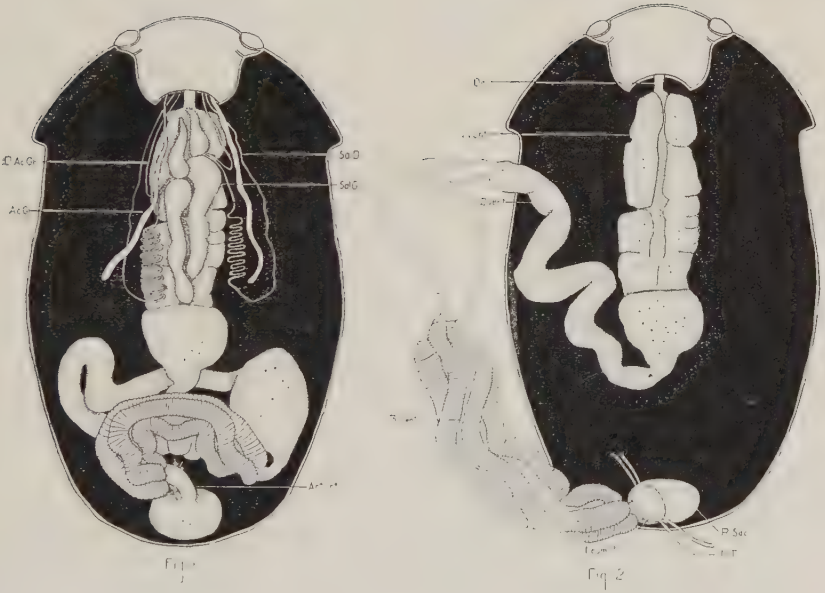
Fig. 11. Cross-section of the third stomach, including the gastric caeca.
Fig. 12. Longitudinal section through the pyloric valve.
Fig. 13. Cross-section of the anterior intestine and ileum.
Fig. 14. Longitudinal section through the anal capsule. The external wall on the right hand side of the drawing is in an abnormal position.

Plate V

Fig. 15. Cross-section through a portion of the wall of the rectal sac.
Fig. 16. Longitudinal section through the principal salivary gland.
Fig. 16a. Longitudinal section through isthmus of principal salivary gland, taken near region of figure 16. Semi-diagrammatic.
Fig. 17. Longitudinal section through the salivary syringe.
Fig. 18. Cross-section through the salivary duct. Note the tongued and grooved nature of the cell walls.

KEY TO THE ABBREVIATIONS USED WITH THE FIGURES

Ac Gl—Accessory salivary gland.
Af D—Afferent duct of the salivary syringe.
Ant Int—Anterior intestine.
Atyp Cell—Atypical or unusual type of cell in rectal epithelium.
Bact?—Bacterial remains (?) in gastric caecum.
Chit Epi—Chitogenous epithelium.
C M—Circular muscle.
Con T—Connective tissue.
Cup—Cupula of the salivary syringe.
D Ac Gl—Duct of the accessory salivary gland.
Ef D—Efferent duct of the salivary syringe.
Epi—Epithelium.
Epi of Proct—Epithelium of the proctodaeum.
Epi of Stom—Epithelium of the stomodaeum.
Epi of Vent—Epithelium of the ventriculus.
Epi Sal Gl—Epithelium of the salivary gland.
Int—Chitinous intima.
Isthmus — Isthmus connecting the anterior and posterior lobes of the principal salivary gland.
L M—Longitudinal muscle.
Lu—Lumen.
Lu An Cnl—Lumen of the anal canal.
Lu Ant Int—Lumen of the anterior intestine.
Lu Ant Lobe—Lumen of the anterior lobe of the principal salivary gland.
Lu Ileum?—Lumen of the pouch into which the Malpighian tubules empty.
Lu Post Lobe—Lumen of the posterior lobe of the principal salivary gland.
Lu Vent 1—Lumen of the first stomach.
Lu Vent 2—Lumen of the second stomach.
Lu Vent 3—Lumen of the third stomach.
M An Sph—Muscles of the anal sphincter.
M T—Malpighian tubule.
Nuc—Nucleus.
Nuc Epi—Nucleus of epithelial cell in the wall of a gastric caecum.
Oper—Operculum of the cibarium.
Piston—Piston of the salivary syringe.
P M—Peritoneal membrane.
Rect Epi—Usual type of cell in rectal epithelium.
Rect Sac—Rectal sac or posterior intestine.
Sal D—Salivary duct.
Sal Gl—Principal salivary gland.
S B—Striated border.
Sec—Globule of secretion.
Tend—Tendon on which the dilator muscles of the cibarium are inserted.
Tend Syr—Tendon of the salivary syringe; pump handle.
Tr—Tracheole.
Valve?—Valve near the posterior end of the second stomach.
Vent Wall—Ventral wall of the cibarium.


Ac Gr
Ac G
Sal D
Sal G
Ant
Fig. 1
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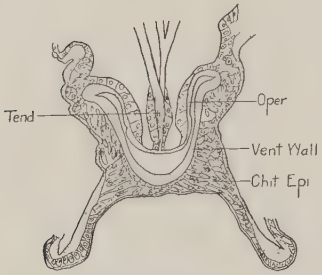


Fig. 3

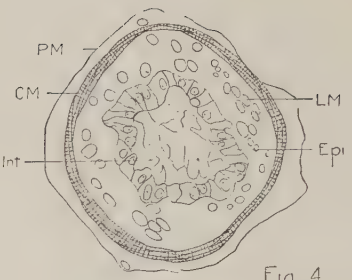


Fig. 4

Fig. 6

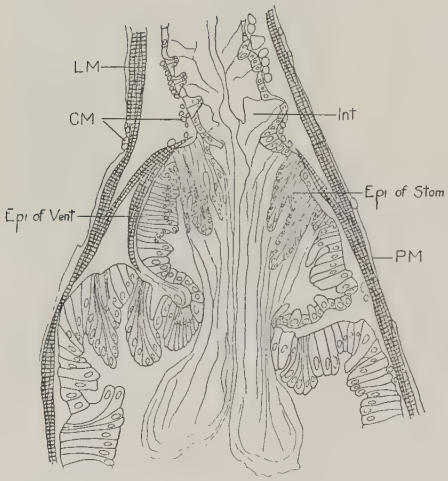


Fig. 5

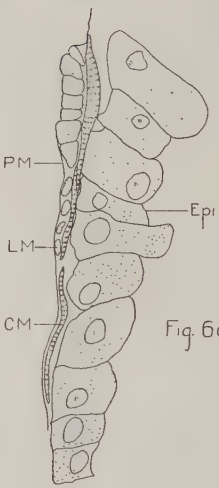
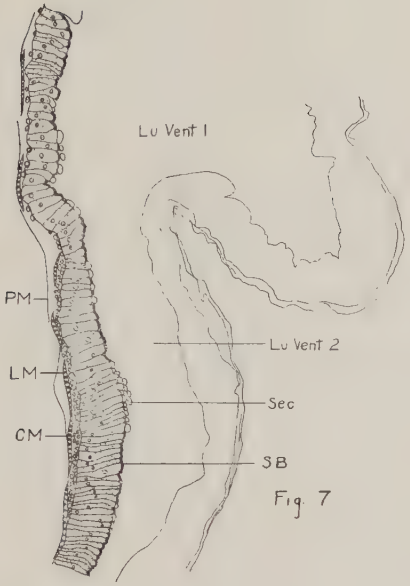


Fig. 6a



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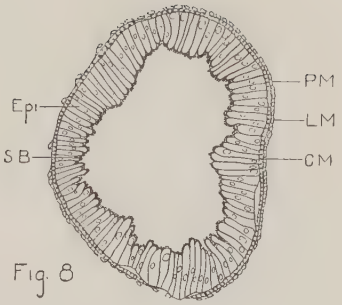


Fig. 8

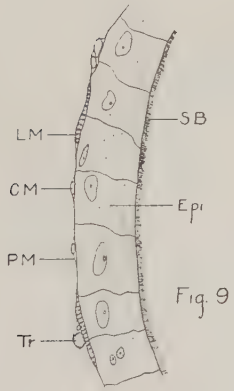


Fig. 9

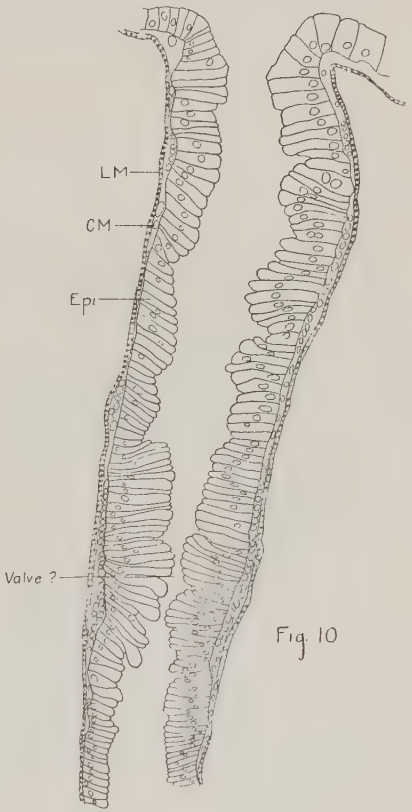
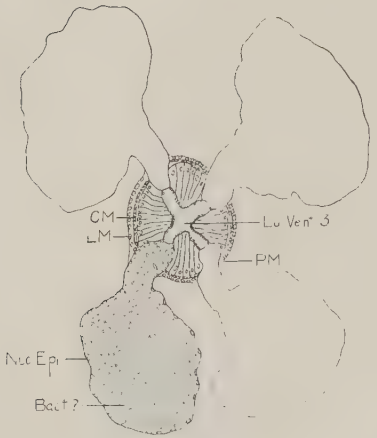


Fig. 10



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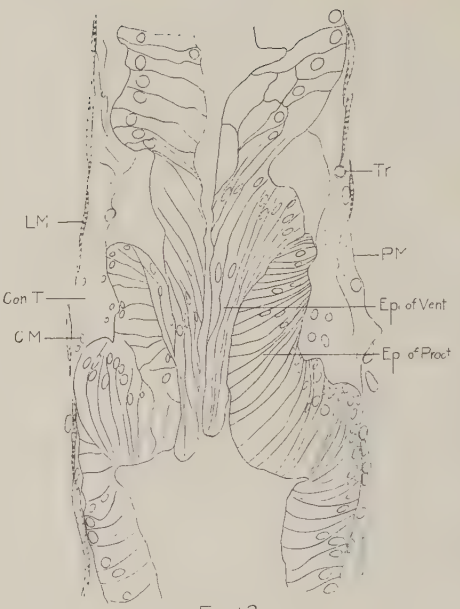

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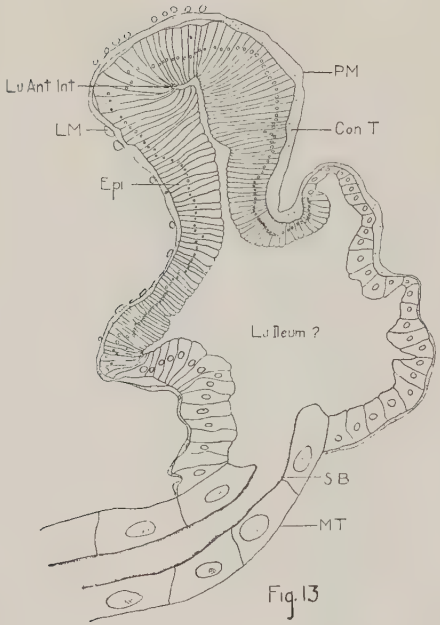

Fig. 13

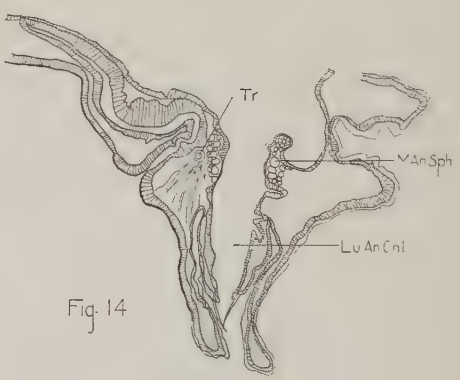

Fig. 14

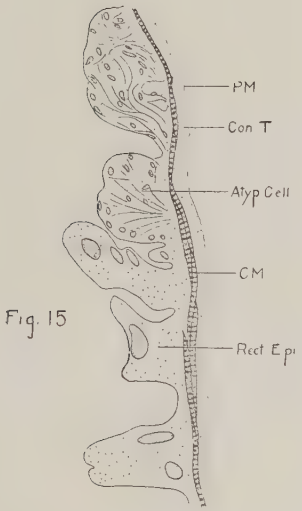

Fig. 15

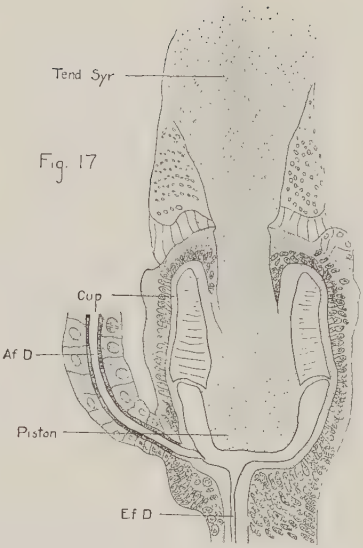

Fig. 17

Fig. 16

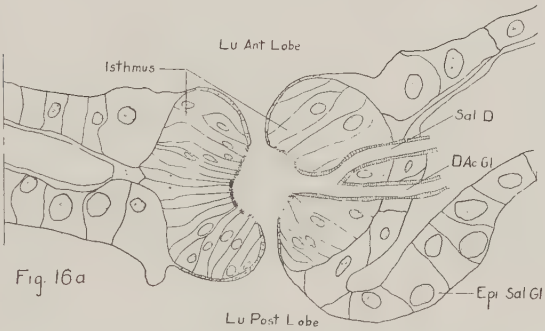

Fig. 16a

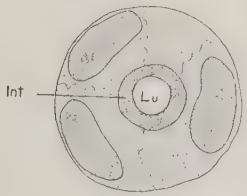

Fig. 18

BOOK REVIEWS

The Grass of Many Waters

This book, to the layman and the general student, is the answer to the frequent question, "What are the Algae, and why should I be interested in them?" Due to the author's wide experience in the teaching profession where such questions are of common occurrence, and because of his subtle humor, he has been able to place before the public an interesting and understandable book. Although not written for those "who know all about the algae," such a specialist will find it to be a sound scientific treatment presented in such a manner as to be enjoyable reading.

Early in the book there is a discussion of the organisms which constitute the Algae. Interwoven with this is a comparison of the physiological processes of these organisms with those of the "higher" plants and animals. The greater part of the book is devoted to algal habitats and the economic importance of these plants to the associated organisms, as well as to man. Methods for collecting, preserving and studying the Algae are included, but as it is not taxonomic in nature, keys have been omitted. Excellent figures, photographs and colored plates add materially to the text for those who are unfamiliar with the group.

The book is a remarkably successful attempt to stimulate interest in, as well as to popularize a group of plants formerly considered to belong only to the specialist.

—*C. E. Taft.*

Algae, the Grass of Many Waters, by Lewis Hanford Tiffany. xii+171 pp. Springfield, Illinois, Charles C. Thomas, 1938. $3.50.

A Philosophy of Science

As a result of examining various historical and contemporary views of the interrelation of science and philosophy, the author concludes that instead of formulating the problem in terms of philosophy vs. science, it must be formulated in terms of a philosophy *of* science. This he proceeds to do, by means of problems in the logic of science, problems in the analysis of the concepts of science, and a series of speculative problems. The views of past and present writers on these various topics are constantly examined and interpreted with the author's own critical comments. A chapter on human freedom throws new light on this question, although no claim is made for a complete answer. The book closes with a chapter on the nature of reality, leaving in the mind of the reader, as all philosophical discussions must do, certain doubts and misgivings, but withal a sense of being, temporarily at least, swept free of cobwebs.—*L. H. S.*

An Introduction to the Philosophy of Science, by A. Cornelius Benjamin. xvi + 469 pp. New York, the Macmillan Co., 1937. $3.50.

Flying

American Wings describes in a popular style the development of modern aviation in America. It is of particular interest because it clearly brings out the many applications which are being made of aviation and the way in which planes must be designed to fit different purposes. Naturally a great deal of attention is paid to military aviation, but chapters also describe the work of the airlines, the service which the Coast Guard can render in emergencies to ships at sea, the growing use of planes for private use, and such special uses as mapping and advertising. Of interest is the description of the auxiliary facilities which are necessary under modern conditions such as the radio beacon, the illumination of airways and fields and ground operations. The book is written in a vein which will appeal particularly to the boy of high school age. In view of this appeal the book is to be commended because it gives a rather frank discussion of aviation as a career although it places its emphasis on piloting and dismisses engineering and other services with a paragraph. The book closes with a brief history of the past and a look into the future. It is profusely illustrated, pictures of military aircraft predominating.

—*W. L. Everitt.*

American Wings, by Captain Burr Leyson. New York, E. P. Dutton and Company, 1938. $2.00.

Twenty-five Years Later

For twenty-five years Walter's "Genetics" has retained a deserved popularity. The fourth edition, stream-lined and modernized, is now off the press, and will undoubtedly prove a worthy successor to the earlier editions. The author has an intimate way of "talking" to his readers in intriguing, sometimes humerous, always piquant style. A host of clever diagrams and illustrations add to the readability. The book is pitched at an elementary level, and can not but appeal to the beginning student. The subject is developed historically, using in their turn the observational, the experimental, the statistical, the cytological and the developmental avenues of approach. The book closes with two realistically presented chapters on human heredity and eugenics. A lengthy appendix contains 84 practice problems, some statistical constants and their use, the tracing of family histories, suggested topics for eugenic theses and numerous other facts and suggestions of use to the teacher.

—*L. H. S.*

Genetics, by H. E. Walter. Fourth edition. xvii+412 pp. New York, The Macmillan Co., 1938. $3.00.

Teaching Biological Sciences

Professors D. F. Miller (Zoologist) and G. W. Blaydes (Botanist) of the Ohio State University, have prepared a book on methods and materials for teaching elementary biological sciences which gives every promise of becoming a valuable guide and reference book for all biological teachers in training and in service. Part I of the book is designed primarily as a text for classes in special methods. The ten chapters in Part I cover those questions most frequently asked by student teachers. Some extremely interesting and important information and points of view are presented under the following headings: the biological basis of education, objectives of teaching, types of courses, methods of presentation, making a teaching plan, an evaluating program, lack of materials and equipment, visual education, how to choose a text and trends in the curriculum. Part II contains information primarily for the use of the teacher already in service. Chapter 12 is "chuck full" of suggestions on how to collect, preserve and culture common fauna and flora near any school. The chapters on laboratory aids and substitutes, preparation for the microscope, digestion, nutrition and growth, diffusion, circulation, respiration, water relations to plants, the response of organisms, reproduction and heredity, contain a great deal of information and suggestions on how much subject matter can be presented and detailed information on the preparation of demonstrations and experiments for lecture or laboratory classes.

The authors emphasize the importance of getting the student's mind away from the printed pages of a text book. So far as possible all facts and principles should be illustrated by visual demonstrations. Many fine examples are suggested in the various chapters of Part II. Briefly stated, the emphasis is "Study nature, not books." For all teachers of biology, especially for progressive individuals, this volume will be of decided value.—*Alvah Peterson.*

Methods and Materials for Teaching Biological Sciences, by D. F. Miller and Glenn W. Blaydes. xii+435 pp. New York, the McGraw-Hill Book Co., Inc., 1938. $3.50.

Insects of Citrus and Subtropical Fruits

For anyone seeking answers to questions on insects affecting citrus and other subtropical fruits (avocado, vinefera grapes, Persian walnut, almond, pecan, fig, olive, date, oriental persimmon, pomegranate, sweet cherry, etc.) undoubtedly the most satisfactory source of information will be Prof. H. J. Quayle's new book, entitled "Insects of Citrus and Subtropical Fruits." This book is the result of a life time study by Prof. Quayle of all the important insects throughout the world that attack commercial subtropical fruits. The author also has assembled the most important world literature in this field. The numerous drawings, diagrams, photographs, tables, keys to insects, and citations to literature make this volume an exceedingly valuable reference for any library housing biological books. An outstanding feature is the extensive and thorough-going presentation of the information about the natural enemies (diseases, predators and parasites) of the respective insect and other arthropod pests. This important phase of insect control is usually

omitted or merely mentioned in most volumes discussing insect pests of economic plants. The chapters on insecticide control, especially the chapter dealing with field fumigation where canvas is placed over trees or ground plants, bring together the latest information in these fields. All told, the author has prepared an excellent book which will be of decided value to entomologists, subtropical fruit growers and others.—*Alvah Peterson.*

Insects of Citrus and other Subtropical Fruits, by Henry J. Quayle. ix+583 pp. Ithaca, The Comstock Publ. Co., 1938. $5.00.

"Reptiles of Ohio" Brought up to Date

Roger Conant's Reptiles of Ohio has at last appeared! Naturalists of the state have for some time eagerly awaited this publication, so badly needed to bring our records up to date. This is the third list of Ohio reptiles to be published, dating from Smith's report in the Ohio Geological Survey of 1882, followed by Max Morse's paper of 1904, published in the Proceedings of the Ohio State Academy of Science. Conant's work is undoubtedly the most thorough-going study of Ohio reptiles yet made. The list includes 4 lizards, 10 turtles, and 25 snakes, based on records and specimens in collections throughout the state, supplemented by collections by the author in 80, and visits to 87, of the state's 88 counties. Each species is fully described along with its habitat and habits. A map of Ohio shows locality records, and a small U. S. map shows the general range of the species. A detailed list of all known specific records is given, with places and dates. This 200-page paper also includes a key to the species, a discussion of the physiography and geography of the state, a glossary, an extensive bibliography, notes on first aid in treatment of snake bite and suggestions for collecting and preserving specimens. The numerous excellent photographs are an attractive feature. It certainly deserves a place on the shelf of every naturalist's library in the state.—*J. W. Price.*

The Reptiles of Ohio, by Roger Conant. Cloth bound, reprinted from The American Midland Naturalist, 20: 1–200, July, 1938. Notre Dame, Indiana, The University Press.

College Physics

This is a text-book in college physics suitable for use in courses for technical students and for use by college sophomores who have had some introduction to the subject. The use of calculus is entirely excluded and only algebra and trigonometry are required. The material is treated in much the conventional order and each section is clearly illustrated. The expository material is written in concise and readable language and should appeal to the reader for whom it is intended. At the end of each chapter is found a list of problems with answers which are useful in clarifying for the student the principles which he has been reading about. As is the case with a great many other books of its kind, far more material is included than can efficiently be covered in two semesters or three quarters, but considered as a whole Dr. Perkins' book should prove itself useful in sophomore college courses in physics for technical and non-technical students.—*H. H. Nielsen.*

College Physics, by Henry A. Perkins. ix+820 pp. New York, Prentice-Hall, 1938. $3.75.

Abbreviated Physics

"The widespread antipathy on the part of most students to the application of mathematical methods" is the authors' reason for preparing "a brief, non-mathematical survey of the whole field of physics." Equations are relegated to an appendix, and replaced in the body of the text by equivalent verbal statements: "the distance covered by a body in uniformly accelerated motion, starting from rest, is equal to the product of half the acceleration by the square of the elapsed time." A four-page appendix tells of the influence of heat engines, electric power, electrical communications, and sound-motion pictures on civilization. Nine pages are devoted to topics of special interest to pre-medical students. As a text-book for short courses in physics, with demonstrations and discussions to make up for extreme brevity of the text, this book may find a useful place.—*Harold Knauss.*

Elementary Survey of Physics, by Arthur E. Haas and Ira M. Freeman. 203+ xii pages. New York, E. P. Dutton and Company, 1938. $1.90.

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